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FUTURE
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UNEARTH THE FULL STORY BEHIND THE LEGEND OF ZELDA

Explore every game in the series and what makes each one so great. If you're a fan, you'll enjoy the trip through time. If you're a newcomer, we offer you this sage advice: "It's dangerous to go alone, take this!"

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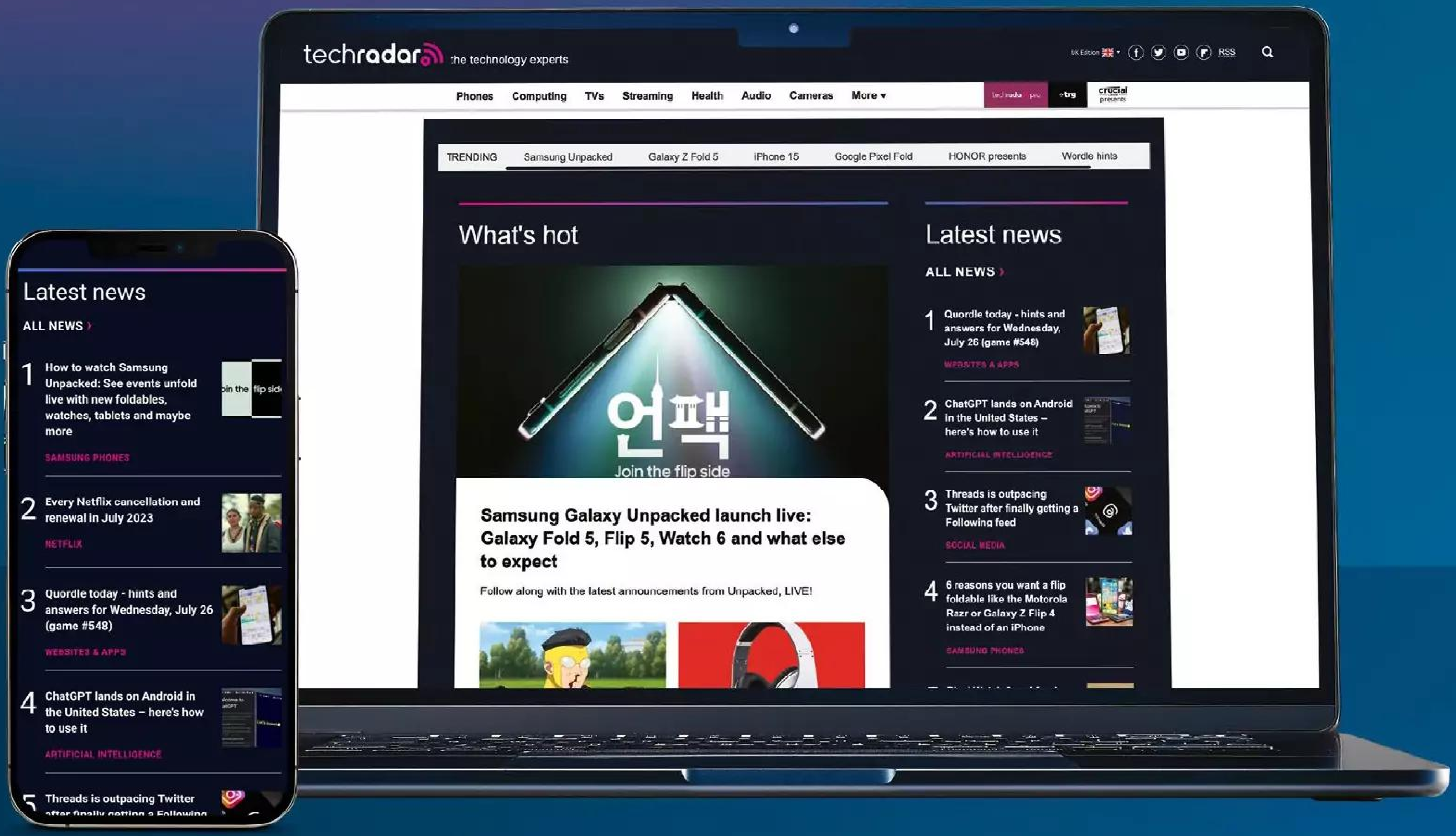

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Guy
Cocker

GREAT EXPECTATIONS

THE RELEASE of a new high-end GPU might just be the most exciting event in PC technology—at least, it ought to be. No question; the arrival of Nvidia's mighty new RTX 5090 (hop on over to page 74 for the review) is a seminal moment. It's the fastest graphics card known to humanity—clearly quicker than the outgoing RTX 4090, itself a beast of a GPU. Yet, it's hard to shake the feeling that the 5090 could—and maybe should—have been better still.

That's partly down to the fact that the price has gone up perfectly in proportion to the added performance, but also thanks to the light the 5090 sheds on expectations concerning upcoming GPUs from further down the RTX 50 stack. All will unfold in the next few issues, but going by both the performance of the 5090 and Nvidia's specifications and benchmarks, there are some disappointments to come.

As important as GPUs are, they are but one element of the PC, let alone the broader technology scene. If you want compensation for the slight excitement shortfall delivered by Nvidia, look no further than our coverage of CES, gleaned by yours truly as I marched across the Las Vegas show floors.

Along with the usual litany of next-gen laptops (Razer had the most alluring new portable), plus the ever-expanding gaming handheld segment, highlights include a new class of 4K OLED monitors, some slick AIO coolers, and AMD's new Strix Halo chip.

The latter is an APU for laptop that's awfully reminiscent of the chips you find in consoles thanks to packing a decent CPU—plus a powerful GPU—into a single package with a shared memory controller. It might very well shake up the mid-range gaming laptop market.

Elsewhere, Zak goes back to PC-building basics with his Blueprints Unwrapped feature from page 44. Sometimes, it's easy to get distracted by the latest technology, and lose sight of the broader issues. How do you pick parts? How do you avoid compatibility issues? Can you future-proof your PC? What's the trick to an ergonomically easy PC build? Zak has the answers to all these questions, and plenty more.

We also have an insight on the subject of emulation. With the release of the Qualcomm Snapdragon X, the PC has arguably made a decisive step toward adopting the ARM architecture, but it's only possible thanks to emulated support for traditional x86 code. The same has been true for the Apple Mac's transition from x86 to ARM. Darien Graham-Smith dives deep into the subject from page 52.

Our tutorials this issue are particularly varied, spanning everything from playing classic arcade games on your PC to using ChatGPT Projects to manage all your AI-accelerated workflows. Over in the labs (page 72 onward), accompanying the monstrous $2,000 RTX 5090 is Lenovo's latest affordable desktop gaming PC which comes in at under half the price of that epic Nvidia GPU for an entire rig.

To the Lenovo, you can add a pair of AMD AM5 motherboards, what might be the best gaming handheld we've tested in the OneXPlayer OneXFly F1 Pro, and what definitely is the best RPG in recent memory—*Kingdom Come: Deliverance 2.* There's definitely no shortage of excitement this month, even if it's probably not thanks to Nvidia.

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

A Mixed Bag: RTX 50 Series Launch

A story of demand, limited supply, and technical challenges

NVIDIA'S LAUNCH of the RTX 5090 and RTX 5080 graphics cards took place on January 30. As many predicted, both sets of 'Blackwell' GPUs sold out quickly. Some buyers even camped outside retailer Micro Center. However, based on user reports, some stores had fewer than a dozen units.

This was anticipated, as Nvidia representatives had warned the public that the number of these GPUs would be highly limited at launch. Unfortunately, this has led to unscrupulous buyers indulging in scalping.

Some listings for the RTX 5090 are as high as $6,000—three times the $1,999 MSRP. We also noted that there are multiple eBay listings that appear to sell the RTX 5090 at the recommended retail price. Upon checking the product listing, we found that the seller was in fact offering a picture of the card for $1,999.

Another interesting aspect of the RTX 50 series launch surrounds the difference between estimated manufacturing costs and retail pricing. No one outside Nvidia knows the exact cost of producing its GB202 graphics processing unit. However, it does have a die size of 761.56 mm^2, making it one of the largest PC GPUs ever. Based on manufacturing techniques, industry analysts have estimated the cost for this to be $290-$340. However, experts have also stressed that Nvidia's price tag must take into account other GPU components, such as the VRAM and board assembly.

> “The RTX 5090 cards sold out quickly

At launch, the company also released version 572.16 WHQL of its GeForce 'Game Ready' driver. This brings substantial improvements to the RTX 50 series, as well as older RTX 20, 30, and 40 cards. These include the software framework for DLSS 4, and updated transformer-based models for 'Video Super Resolution', which Nvidia claims benefits from up to 30 percent less GPU resource usage at its highest quality setting.

Those who obtained an RTX 5080 or RTX 5090 also don't need to wait for a title to support DLSS 4. The 'DLSS Override' feature allows users to deploy DLSS 4 in games that don't natively support it.

Despite the promise of the RTX 50 series and associated drivers, there have been reports of stability issues with the RTX 5080 Founders Edition. Pro Overclocker 'Roman 'der8auer' Hartung' posted a video of his review sample of the RTX 5080 FE on January 29, complaining of boot failures and crashes in PCIe 5.0 mode.

It seems to stem from signal integrity issues when the GPU is running at PCIe 5.0 speeds. The issue is especially apparent for gamers using a riser cable with Blackwell GPUs. Users can resolve the stability problems by manually setting the PCIe configuration to Gen 4.0 in the BIOS.

While it's common for GPU manufacturers to send sample graphics cards to reviewers ahead of launch, Nvidia's attempts proved controversial. Outlets like Tom's Hardware reported that some reviewers' versions of the RTX 5090 were labeled 'Press Build'. Ian Cutress of TechTechPotato light-heartedly speculated on X that this could be a case of 'Press Binning'. In other words, Nvidia may have detected that some RTX 5090 GPUs performed slightly better than others, and deliberately sent these to the press to gain more favorable reviews. Nvidia quashed these rumors, claiming the models were identical to retail GPUs.

Meanwhile, AMD has claimed that its RX 7900 XTX GPU outperforms Nvidia's 'Ada Lovelace' GPU, the RTX 4090, by up to 13 percent when running DeepSeek R1 Distill Qwen 7B. However, independent benchmarks have shown that AMD's GPU doesn't perform as well at handling non-AI workloads.

TechSpot reviewers ran the most up-to-date version of *The Last of Us Part I*, and found that the 7900 XTX was 23 percent slower at 1080p, 20 percent at 1440p, and 21 percent at 4K, compared to the RTX 4090.

As the dust settles, both gamers and reviewers will be watching closely to determine how Nvidia will handle supply and technical issues. **–ND**

TIKTOK GOES BACK AND FORTH

TIKTOK'S US FATE: RESTRICTIONS, REPRIEVE, AND RESALE

ON JANUARY 19, TikTok briefly shut down all US-based accounts and removed its app from the Apple and Google Play mobile stores. This was in response to a decision by the US Supreme Court that upheld a law requiring TikTok's parent company, ByteDance, to divest, or be banned. However, the blackout was short-lived, as the following day, President Trump signed an executive order delaying the ban's enforcement by 75 days.

This reprieve has renewed interest from parties intent on buying the platform. Elon Musk and YouTube star MrBeast have both been touted as eyeing a possible 50 percent stake in TikTok's US operations. President Trump has said he is open to this idea. However, under law, it is ultimately his decision as to whether part-US ownership of the platform is sufficient to decide it isn't controlled by a 'foreign adversary'.

The app remains unavailable in US app stores. This has led to listings on auction sites for cellphones with the app preinstalled, occasionally for thousands of dollars. **–ND**

APPLE CHIPS HACKED

Exploits can expose web browser pages

M3
M3 PRO
M3 MAX

RESEARCHERS HAVE found two vulnerabilities in Apple's latest generation of Apple A- and M-series chip sets. The exploits, named 'FLOP' and 'SLAP', can take advantage of execution flaws in chips manufactured since 2021.

Bad actors could craft malicious websites to access information from other open tabs in Chrome or Safari. This could potentially include information that's encrypted in transit like credit card payment details. This attack can be executed on Macbooks, Mac computers, iPads, and iPhones.

The vulnerabilities could potentially allow malicious websites to read unauthorized sections of memory. Apple says it plans to address these vulnerabilities in an upcoming security update.

In the meantime, Mac users can use privacy-focused open-source browsers like Brave or LibreWolf. **–ND**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **RED DEAD REDEMPTION II HITS NEW STEAM RECORD**
It's reached a peak concurrent player count of 86,717.

✓ **SONY BACKS DOWN**
PSN account logins are now optional for the PC versions of games like *Spider-Man 2*.

✓ **BOOKS NOT WRITTEN BY AI TO GET CERTIFICATION**
The US-based Authors Guild has launched a new project allowing authors to certify that their book was written entirely by humans.

TRAGEDIES

✗ **850,000 PEOPLE'S DATA EXPOSED IN BREACH**
Insurance giant Globe Life has admitted that data was stolen.

✗ **TESLA RECALLS MORE THAN 239,000 VEHICLES**
A circuit board on certain vehicles may short, knocking out the rear view camera.

✗ **OPENAI O3 MODEL ACCUSED OF CHEATING**
Developer EpochAI admitted that OpenAI had helped on the FrontierMath benchmark test.

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intel
CORE
ULTRA

INTEL LAUNCHES CORE ULTRA 200HX AND 200H CPUS

Arrow Lake architecture will deploy to laptops

INTEL has launched its new Core Ultra 200HX and 200H mobile processors, bringing Arrow Lake to laptops. The Core Ultra 200HX series is aimed at 'enthusiasts' and gamers. It offers up to 24 cores (eight Performance-cores and 16 Efficient-cores) based on the new Lion Cove and Skymont architectures.

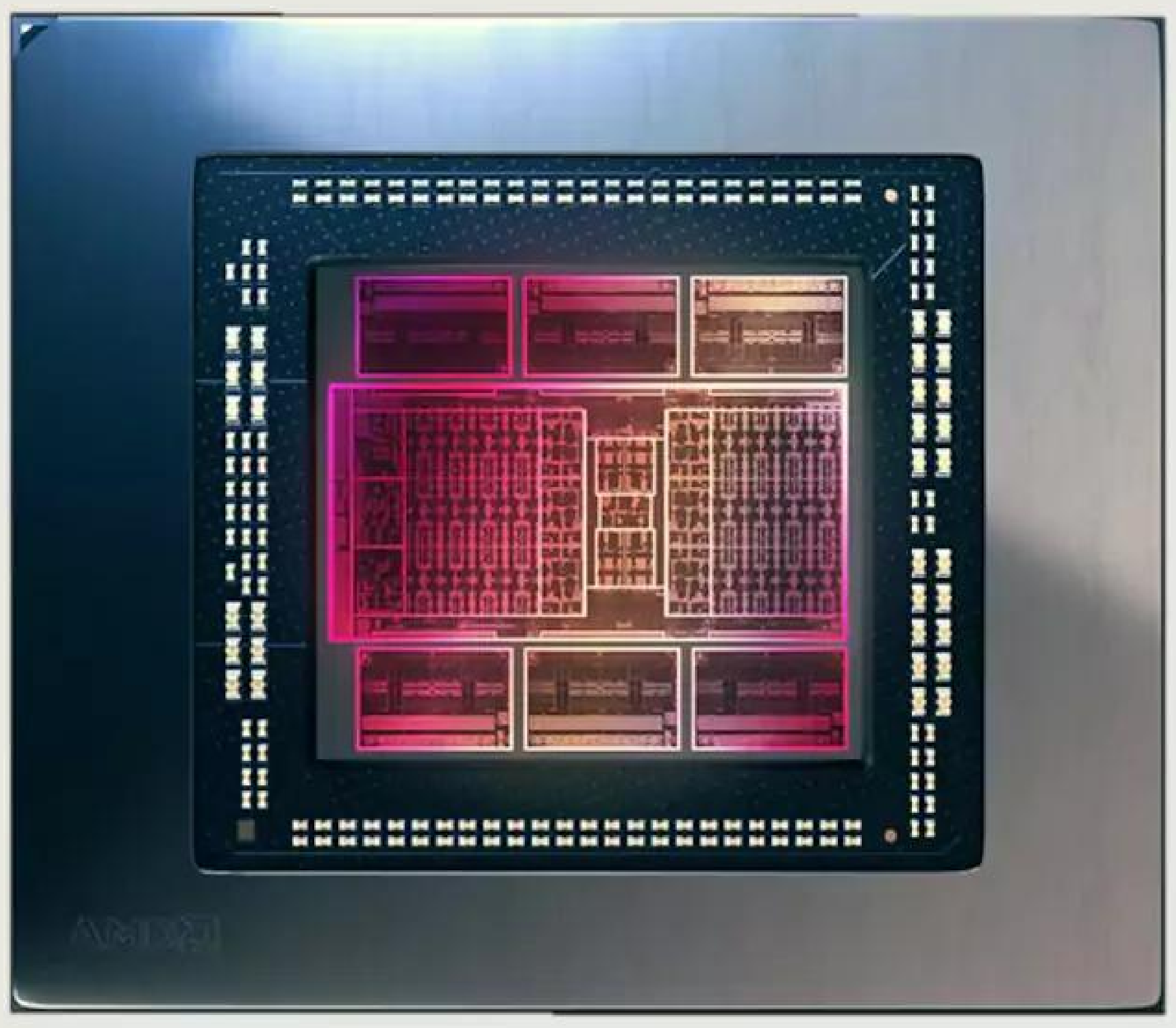
The flagship Intel Core Ultra 9 285HX can boost up to 5.5GHz. The company claims this offers a five percent increase in single-threaded performance and a 20 percent boost in multi-threaded performance compared to the previous Raptor Lake refresh chips. It also has four GPU cores, and a 13 TOPS NPU.

For Intel's consumer laptops, the Ultra 200H series offers up to 16 cores (six P-cores, eight E-cores, and two low-power E-cores). They will also feature integrated Intel Arc graphics with up to eight Xe cores, with a base power of 28 watts. The 200H series is a step up on AI performance, with 99 TOPS across the CPU, GPU, and NPU.

Compared to the AMD Ryzen AI 9 HX 375, the Core Ultra 9 285HX reportedly delivered 42 percent more performance in Geekbench 6.3, 203 percent more in Blender 4.3.0, and 44 percent faster in OpenFOAM. The company also claimed that the chip can deliver 25 percent more at the same power.

The latest processors also come with some respectable platform improvements. This includes support for the Thunderbolt 5 standard, as well as Wi-Fi 7. Certain 200HX models will also support enhanced overclocking.

Over 100 laptop models are due to feature the 200H series chips in 2025. More than 40 gaming laptops will also ship with 200HX processors in late Q1. Then, independent benchmarks will establish whether Arrow Lake's move to laptops stack up against AMD and Apple. **–ND**



AMD DELAYS RDNA 4

We might have to wait for the new graphics cards

AMD HAS ANNOUNCED a delay of its RDNA 4 graphics cards, pushing the release to March 2025. The tech giant's next-gen GPUs, the Radeon RX 9070 and RX 9070 XT, were slated for the start of this year.

David McAfee, AMD's vice president and general manager of the Ryzen CPU and Radeon graphics division, explained on X that the delayed rollout is due to the extra time required to optimize the software stack and allow more titles to support FidelityFX Super Resolution (FSR) 4.

It makes sense that AMD wants the RX 9070 and RX 9070 XT to deliver optimal performance. However, B&H listed four Asus RX 9070 XT (and non-XT) cards with a preorder date of January 23. Other outlets, like Asus, also teased late January.

There's been speculation that AMD's changed strategy is due to the upcoming RTX 5070 Ti, expected to hit the market in February. AMD may be waiting to discover how Nvidia's offering fares before it finalizes its own products and retail prices.

One of the most anticipated features of the RDNA 4 architecture is FSR 4—AMD's latest upscaling technology. Unlike previous iterations, this will be exclusive to RDNA 4 GPUs. This has been confirmed by developers examining unofficial Radeon driver builds, who discovered that FSR 4 uses a machine-learning algorithm with an 8-point floating-point implementation. This requires FP8 WMMA (Wave Matrix Multiply Accumulate) support.

While the delay will be a disappointment to gamers, David McAfee has hinted that AMD plans to ramp up availability of RDNA 4 cards. This is hopeful news, given that Nvidia's first RTX 50 releases sold out in just over 20 minutes. **–ND**

'Tar Pit' traps built to devastate AI scrapers

WEB DEVELOPERS HAVE struggled with the bandwidth and costs associated with 'scraping' activities from automated tools. For instance, in July 2024, Anthropic's ClaudeBot web crawler hammered iFixit almost 1 million times in 24 hours. This was a clear violation of the website's terms and conditions.

One anonymous ethical hacker, known only as 'Aaron', has started to fight back through the creation of 'Nepenthes'. Named after the predatory pitcher plant, this is primarily designed to target crawlers that scrape data for LLMs.

The developer's site (zadzmo.org) explains that Nepenthes works by generating an endless page sequence. These have dozens of links that bounce back to the 'tarpit', making a loop in which an AI crawler can get stuck.

Pages are randomly generated in a deterministic way. This means they appear to be unchanging static files, fooling the crawler into thinking it's exploring real content. The tool also adds delays, both to prevent overloading the host server and waste the crawler's time. The main site contains a demonstration of Nepenthes in action, where a page slowly generates gibberish. This is because the demo includes an implementation of a 'Markov babbler', which uses Markov changes to produce random sentences.

The effectiveness of tools like Nepenthes is debatable. Modern crawlers use timeout mechanisms and priority scheduling to avoid being bogged down. Some AI developers skip link/content extraction from pages that take a long time to load.

OpenAI has promised to deliver a tool to make it easy for website administrators to prevent content being used to train its models. However, it has yet to deliver. **–ND**

Nepenthes is named after the carnivorous plant.

Facebook flags Linux as 'security threat'

Facebook has been facing a backlash after banning posts mentioning Linux content. Users have faced account restrictions, along with posts refused because "[It] may facilitate the sharing of malicious software."

The issue came to light when popular Linux OS database DistroWatch reported that links to the site were blocked. Despite appealing the ban, DistroWatch representatives were told that Linux-related material would remain on the cybersecurity filter.

This ban is puzzling, given that Facebook deploys Cent OS Stream on its servers and uses Fedora Linux on its workstations. For now, DistroWatch has advised using its RSS Feeds or Mastodon to view Linux content. **–ND**

Copilot+ PCs get local DeepSeek-R1 support

Microsoft has announced NPU-optimized versions of DeepSeek-R1 for Copilot+, starting with Qualcomm Snapdragon X. This will be followed by the Intel Core Ultra 200V and others.

DeepSeek-R1-Distill-Qwen-1.5B will be available in the AI toolkit, with the 7B and 14B variants to follow.

DeepSeek's model offers similar functionality to contenders like OpenAI, but computes around 11 times more efficiently. Microsoft claims its impact on battery life will be 'minimal'.

This makes it ideal for consumer devices, but it's not clear why Microsoft has targeted Qualcomm Snapdragon X PCs first, given that modern Intel and AMD laptops also have built-in NPUs. **–ND**

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Jarred Walton

TECH TALK

Nvidia Multi Frame Generation put to the test

NVIDIA'S BLACKWELL RTX ARCHITECTURE was announced last month. I've now had plenty of one-on-one time with the RTX 5090 and RTX 5080, and I want to talk more about Multi Frame Generation (MFG) in particular, because it's a major marketing bullet point for the RTX 50-series GPUs.

***Alan Wake 2* running with full RT effects was the best overall experience with MFG; other games range from decent to pretty mediocre.**

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Where DLSS 3 interpolates one frame between two rendered frames, MFG can generate one, two, or three frames. Nvidia calls this MFG 2X, 3X, and 4X modes, with the last being "up to twice as fast" as 2X framegen. A factor in making MFG work is that the AI network needs to run faster than before.

Plenty of games with DLSS 3 support seemed to hit a bottleneck with the OFA fixed function hardware, yielding less than stellar improvements in frame rates. My experience with DLLS 3 is that you want it to give at least a 50 percent boost to frame rates, with 80 percent or more desirable. If it only manages a 30–40 percent, it typically ends up feeling worse than non-framegen performance.

Take a game running at 50fps without framegen. An 80 percent boost pushes that up to 90fps, but user input sampling only happens every other frame, so the input sampling rate drops from 50 IPS (inputs per second) to 45 IPS. The smoother visuals make up for the reduced IPS and higher latency, and the game ends up feeling 'better'—with the understanding that what feels acceptable varies by the individual user and game.

A 50 percent boost means going from 50fps and IPS, to 75fps and 37.5 IPS with framegen. 75fps looks smoother, but increasing the input latency and dropping the IPS by 25 percent doesn't necessarily feel better. If framegen only yields a 30 percent increase, it would give 65fps and 32.5 IPS. That's a 35 percent reduction in input sampling rates coupled with higher latency. This rarely feels better than non-framegen to me. I would estimate that probably half to two thirds of all DLSS 3 enabled games only saw a 30–50 percent benefit.

With MFG being a faster algorithm, more games should see an 80 percent or more increase in frame rates from MFG 2X. Then it takes another step forward with multiple frames, often scaling nearly linearly. A game may see an 80 percent boost from MFG2X, 160 percent from MFG3X, and 240 percent from MFG4X. There's also 'flip metering' hardware to pace generated frames more evenly.

You're probably wondering about the experience. MFG runs the gamut from good to okay to mediocre—like framegen. *Hogwarts Legacy* had uneven frame pacing, so even though MFG gave good results in raw numbers, the added latency and inconsistent pacing didn't feel great.

Cyberpunk 2077 was better, with 3.3X the performance: 195fps compared to 59fps. Even if IPS dropped from 59 to 49, it was responsive and smooth enough that the result felt good—preferable to non-MFG mode.

Alan Wake 2 was the best, thanks to being a slower-paced game. With full RT and DLSS Quality upscaling on the 5090, it went from 48fps to 166fps, 3.46X the performance. IPS dropped from 48 to 42 with MFG4X, but, the smooth presentation of frames to the 240Hz adaptive-sync monitor looked great.

But there are limits to what MFG can do, and we need to be careful when looking at 'performance'. 100fps without framegen feels very responsive. 100fps with framegen feels fine, but less responsive than native because you're only getting 50 IPS. And 100fps with MFG4X? It might be playable, but it's not the same as native 100fps, as it would be down to 25 IPS.

So no, Nvidia, the RTX 5070 is not as fast as an RTX 4090. The experience isn't even comparable.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE BEST HANDHELD GAMING PCS

A dream shared by PC gamers everywhere has been to take our entire gaming PCs on the go. The latest generation of gaming handhelds deliver on that portable nirvana, enabling gaming from near enough anywhere. But which one should you go for? A key choice is between SteamOS and Windows—after that, you generally have to play off size against power. Here are the ones that get our recommendation.

5 AYANEO FLIP DS

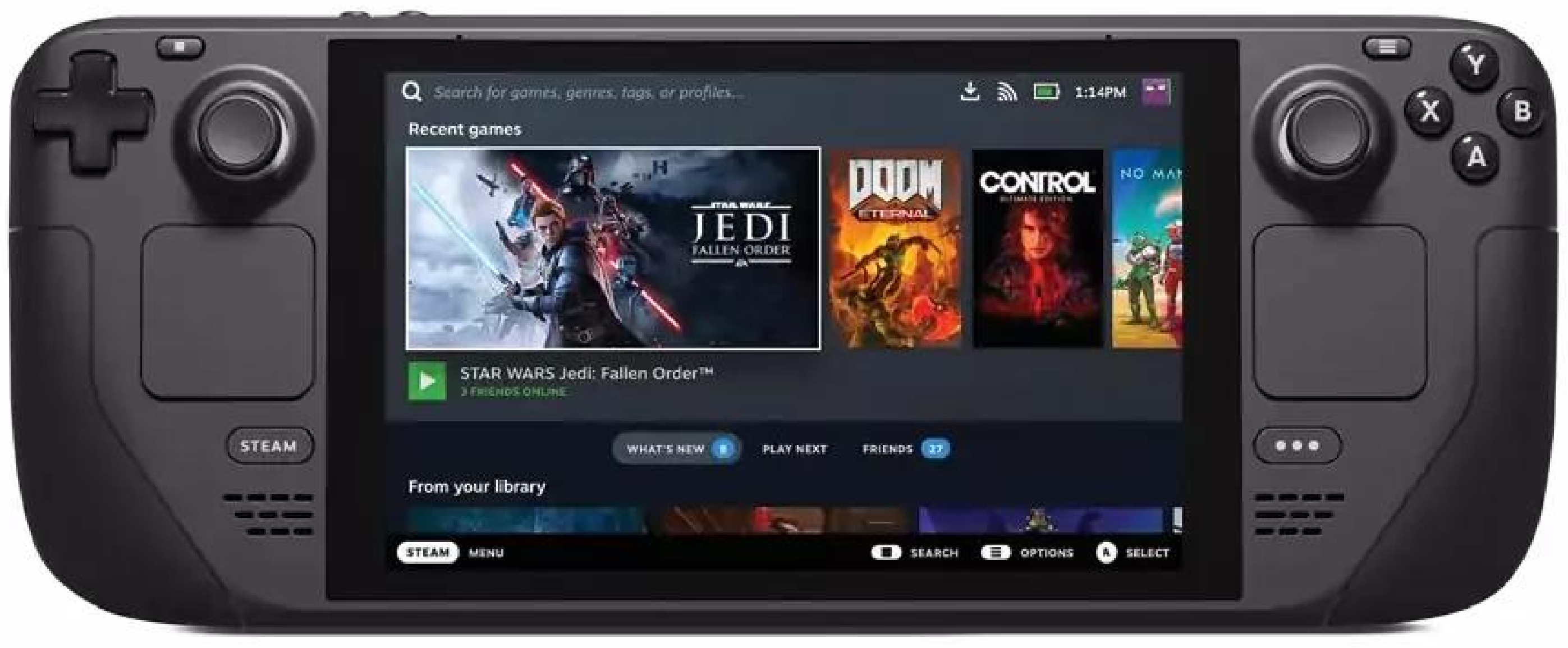
This is compact, portable, and versatile. Its dual-screen setup allows for clever trackpad and keyboard solutions to handheld navigation woes. What's more, it's not only small, but safer in a backpack, given the screens and controls are somewhat protected when closed. However, you sacrifice a little performance for the design. If it's value for specifications and performance that you want, there are better options. **$779 www.ayaneo.com**

4 LENOVO LEGION GO

The Lenovo Legion Go has a huge screen, although you'll want to turn down the resolution a tad for the best performance. It also features detachable controllers that really make it stand out. It's powered by the same AMD Ryzen Z1 Extreme as the Asus ROG Ally X, but while the screen is capable of 1600p, you'll want to stay at 1080p in the majority of games to get decent frame rates. **$550 www.lenovo.com**

3 ONEXPLAYER ONEXFLY F1 PRO

With AMD's Strix Point APU powering performance, this is one of the most impressive portable PCs on the market. The catch? You really pay for that shiny new AMD chip. Still, with a 144Hz OLED panel, and the combination of 32GB of RAM and 1TB of SSD storage, this is a cracking handheld. The downside is that the 48.5 Wh battery won't get you much game time without mains power. **$1,499 www.onexplayerstore.com**



2 STEAM DECK

The Steam Deck is unbeatable in one very important way: it's far cheaper than most of the competition. It also boasts SteamOS, which is better optimized for small-screen gaming than Windows, although SteamOS is now beginning to roll out to other devices. If you're wondering where the Steam Deck OLED fits in, its higher price makes it hard to recommend versus better-value Windows handhelds. **$399 www.steampowered.com**

1 ASUS ROG ALLY X

Every flaw in the original ROG Ally has been fixed in the Ally X, and with a huge battery, it gives you hours of great gaming. RAM has been increased from 16 to 24GB of LPDDR5-6400, which helps games to run smoother, while Asus has tweaked the cooling system to prevent components from bouncing off thermal limits. Along with the extra memory, it performs faster. Thus, Asus ROG Ally X is the new bar for other handheld gaming PCs to reach. **$1,200 www.asus.com**

© AYANEO, LENOVO, ONEXPLAYER, STEAM, ASUS

Jeremy Laird

TRADE CHAT

Fare well, RTX 4090

NVIDIA'S VERY HIGHEST-END GPUs are the best value. There, I said it, and now everyone can shoot me down, call me a shill, and dance on my hastily dug grave. But before you ramrod your muskets and cock your flintlocks, let me elaborate. This is not hyperbole, but a genuine point of view.

Nvidia, as we all surely know, has launched its new RTX 50 family of graphics cards. Duly, the RTX 5090 is an absolute monster—all $2,000 of it. Meanwhile, the rest of the RTX range actually came in cheaper than expected. Surely that makes the '90 card more irrelevant than ever?

Up to a point, absolutely. How many of us can afford $2,000 on a GPU? But hang on. Let's say you bought an RTX 4090 at launch just over two years ago. Just to fluff up my argument a bit, I'm going to assume you managed to bag one at the $1,600 MSRP. Some people actually did, albeit plenty more had to pay over the odds.

Well, here you are over two years later, and if you ignore the marketing fluff, the new RTX 5090 looks to be about 30 percent quicker than your RTX 4090. The new RTX 5080 is at best comparable to your RTX 4090. What's more, the RTX 40-series is compatible with the really important bit of the new DLSS 4 suite of features, namely the new transformer-based upscaling. Yes, the 3x frame gen feature has grabbed a lot of headlines, but its benefits are much more ambiguous.

The problem with frame gen is that it doesn't really work when you most need it. More specifically, it does nothing to help with latency; it actually worsens it, albeit by an impressively small amount. Anyway, the point is that massively adding to the frame rate when, say, your base performance before frame gen is something terrible like 15fps, won't stop the game from feeling laggy as heck.

So, with an RTX 4090 in my rig, the bottom line is that I'd still need an RTX 5090 to get a really substantial, worthwhile upgrade. The RTX 5080 won't do. And here's the kicker: that's likely to be true for the whole life cycle of the new RTX 50 family. Again, this very likely means another two years. In other words, if you bought an RTX 4090 at launch, you've got four years with either absolutely the fastest thing out there, or the second fastest and still a very performant card.

> The new RTX 5090 looks to be about 30 percent quicker than your RTX 4090

Weirdly, Nvidia's $1,600 RTX 4090 has turned out to be stellar value.

That's $1,600 for four years of bleeding-edge gaming, or $400 a year. That's what I think is good value. As an alternative, let's say you bought an RTX 4070 at launch. That's $600. Two years later, you're more likely to feel a bit left behind. The 4070 was only a little bit better than the 3070, and it's probably beginning to struggle a bit on some of your favorite new titles.

The odds that you might feel the need to upgrade that '70 level card each gen are much higher, but then, that'll be $600 for the 4070 and $550 for a new 5070 to replace it. That's $1,150 instead of the $1,600 you might have spent on a 4090. But don't kid yourself; you're not getting anywhere near the same experience. I think you'd need to go to at least the new RTX 5070 Ti to get a noticeable upgrade, so that's even more money.

Definitely don't go thinking that the 5070 Ti you just bought is going to give as good an experience as a 4090. It might crank out some big numbers with that new 3x frame gen tech, but that won't help with latency in games where it's beginning to struggle.

Of course, the problem with this argument is the huge upfront cost of $1,600. It's enough to rule many of us out from the get go. I do understand that, but if you could afford a 4090 at launch, and you got one at MSRP, I maintain that you got the best-value GPU of the last generation by far and one that will serve you very well for another couple of years.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

© NVIDIA

DOCTOR

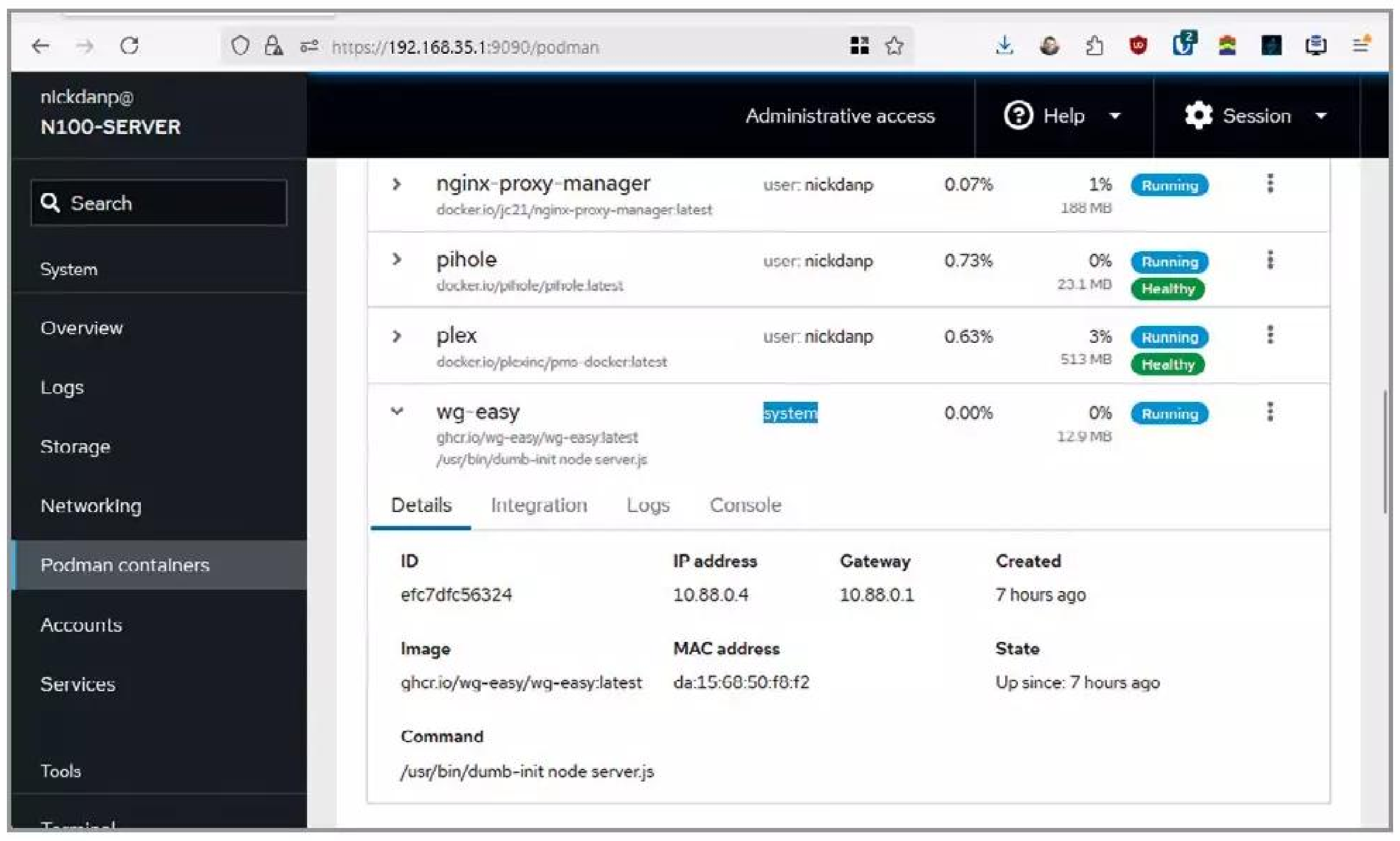
THIS MONTH THE DOCTOR TACKLES...

> VPN server issue
> Wot, no Bitdefender?
> Windows off-screen

WireGuard connection problem

I diligently followed your tutorial in the June 2024 issue to create myself a WireGuard VPN server using wg-easy. It worked fine for months, but recently, I've noticed that I can no longer connect to the IP address of the server running WireGuard. I can still connect to other devices on the network, and use the VPN to browse safely over untrusted public Wi-Fi networks, but the server itself is off limits, which locks me out of various services I've kept offline. Why is this happening, and—more importantly—how do I fix it? **— Michelle D Burns**

THE DOCTOR RESPONDS: This is almost certainly linked to Podman's recent networking changes, as outlined in my November 2024 column, exacerbated by the fact that you're running wg-easy as a rootless container as per our original guide. The Doc is still searching for a fix that will enable you to run WireGuard rootlessly going forward under the new networking stack, but he has discovered the container works perfectly when run using the root user, which serves as a workaround until a permanent fix has been developed.



nginx-proxy-manager docker.io/jc21/nginx-proxy-manager:latest user: nickdanp 0.07% 1% 188 MB Running

pihole docker.io/pihole/pihole:latest user: nickdanp 0.73% 0% 23.1 MB Running Healthy

plex docker.io/plexinc/pms-docker:latest user: nickdanp 0.63% 3% 513 MB Running Healthy

wg-easy ghcr.io/wg-easy/wg-easy:latest /usr/bin/dumb-init node server.js system 0.00% 0% 12.9 MB Running

ID: efc7dfc56324
IP address: 10.88.0.4
Gateway: 10.88.0.1
Created: 7 hours ago
Image: ghcr.io/wg-easy/wg-easy:latest
MAC address: da:15:60:50:f8:f2
State: Up since: 7 hours ago
Command: /usr/bin/dumb-init node server.js

Run wg-easy under root on Debian systems.

To do this, shut down and delete both your original wg-easy container and the pod you enclosed it in, which is now redundant. Now, type the following in a text editor:

```
sudo podman run -d \
  --replace \
  --name=wg-easy \
  -p=51820:51820/udp \
  -p=51821:51821/tcp \
  -e WG_HOST=yourhost.com \
  -e PASSWORD_HASH='xxxxxxxx' \
  -e WG_MTU=1420 \
  -e WG_ALLOWED_IPS=192.168.1.0/24 \
  -e WG_DEFAULT_DNS=192.168.35.254 \
  -v ~/container-data/.wg-easy:/etc/wireguard \
  --cap-add=NET_ADMIN,NET_RAW,SYS_MODULE \
  --cap-drop=MKNOD,AUDIT_WRITE \
  --sysctl="net.ipv4.conf.all.src_valid_mark=1" \
  --sysctl="net.ipv4.ip_forward=1" \
  ghcr.io/wg-easy/wg-easy:latest
```

There's one key change from past versions of wg-easy—the PASSWORD field is now PASSWORD_HASH. You'll need to generate a hash from your password, so issue the following command:

```
podman run --rm -it ghcr.io/wg-easy/wg-easy wgpw 'YOUR_PASSWORD'
```

Copy the password hash generated into your script above. You'll also need to adapt the WG_HOST, WG_ALLOWED_IPS and WG_DEFAULT_DNS variables to your current setup. Once done, save the script, then copy and paste it into the Cockpit Terminal. You should see wg-easy immediately start up—you'll need to disconnect and reconnect any clients, but no other setup is required, and you should now have full access to all your services.

Install location query

I've noticed that when I install certain programs, I'm given the option of installing either for the current user only or for all users. As the only user of my PC, is there any circumstance in which choosing All Users might prove the better choice?

— Chris Marr

THE DOCTOR RESPONDS: This option is offered by programs that don't require administrative access to function. This means that when you choose the Current User option, the program installs itself in a folder that isn't restricted to administrators, which is

© PODMAN

submit your questions to: doctor@maximumpc.com typically somewhere in your own user folder like 'C:\Users\{username}\AppData\Local\Programs' to ensure it remains private. Choosing All Users would typically install the program in either C:\Program Files or C:\Program Files (x86). Both folders are accessible to all users on your system, but for security reasons, require administrator access to write into.

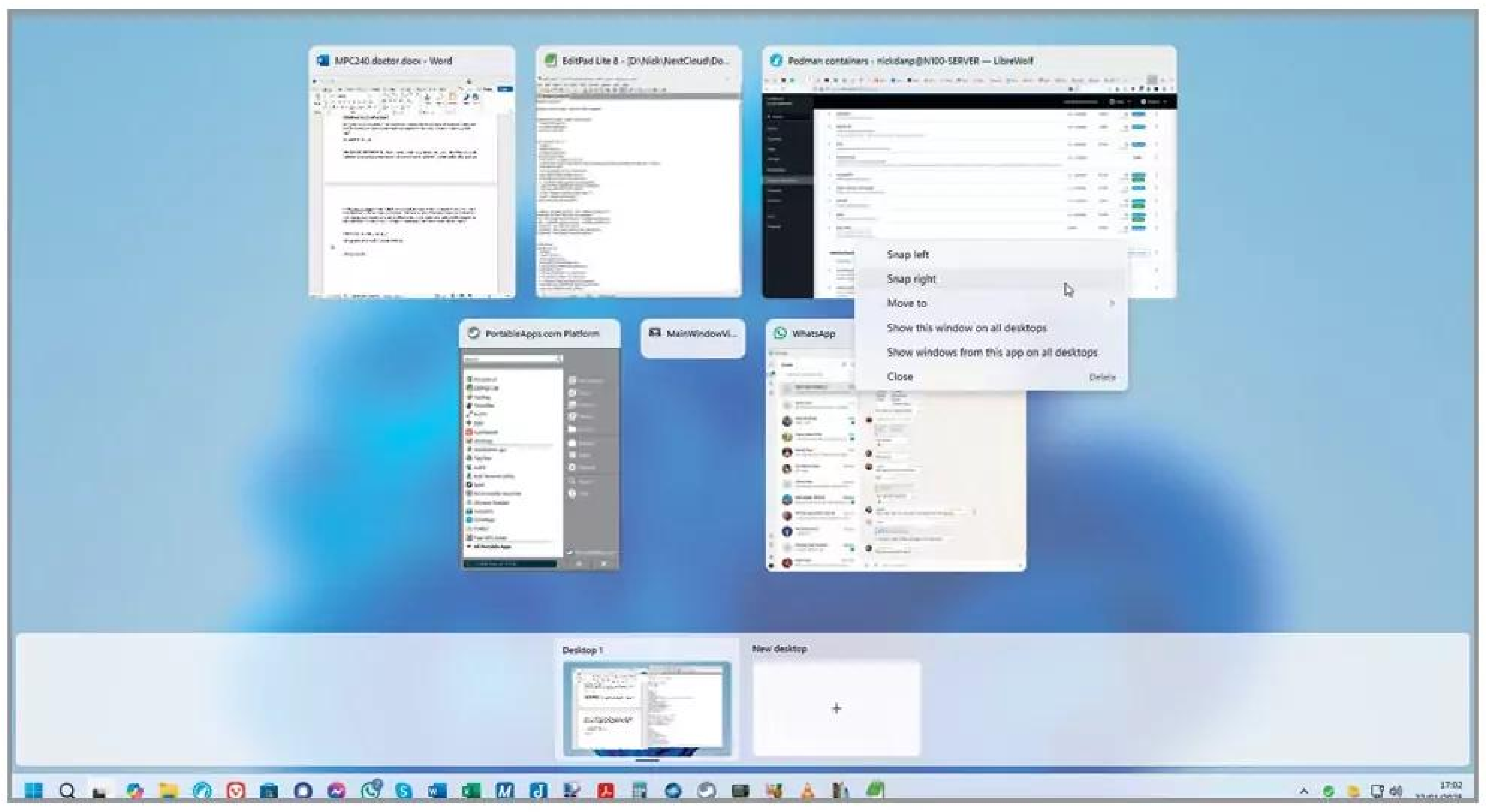
The choice is yours, but while you may think there's no reason why you'd ever want to choose All Users, there are a handful of scenarios where it might be advantageous. For example, if you have a small boot drive, you may have moved your user folder to a larger secondary drive to free up space on your primary drive. This drive may be slower. Choosing Current User would install the application in question to this slower drive, so depending on the size of the program you're installing and its demands, you may wish to install it for all users to ensure it's placed on your fastest drive.

Bitwarden Android problem

My self-hosted Vaultwarden setup has developed a problem after running almost faultlessly for 12 months. I can no longer access my password vault on my Android phone, even though I can still access it through any browser extension or by logging in directly through the web vault. It tells me there's an unspecified error, but its only advice is to retry—of course, nothing happens when I tap to refresh. I've removed and reinstalled the app, plus tried restarting the container, all to no avail.

— Ted H Davis

THE DOCTOR RESPONDS: This is linked to the recent UI refresh that Bitwarden started rolling out last year. One of Podman's biggest weaknesses is that it's not straightforward to configure your containers to periodically check for updated images, never mind install them. As a result, your Vaultwarden installation is likely outdated—the container image is refreshed on a regular basis, often once or twice a month—so it's likely your version predates the critical 1.31.0 release from July 8 2024, which rolled out "initial support for the beta releases of the new native mobile apps".


MPC240.doctor.docx - Word
EditPad Lite 8 - [D:\Nick\NextCloud\Do...
Podman containers - nickdanp@N100-SERVER — LibreWolf
Snap left
Snap right
Move to
Show this window on all desktops
Show windows from this app on all desktops
Close
Delete
PortableApps.com Platform
MainWindowVi...
WhatsApp
Desktop 1
New desktop

Use Win + Tab to recover 'lost' app windows.

© MICROSOFT

Luckily, the fix is simple. First, back up your password vault (the Doc uses Bruceforce's container from https://github.com/Bruceforce/vaultwarden-backup, which works fine with Podman). Once done, shut down your Vaultwarden container. Pull the latest version of the container—if you're using the Cockpit web interface, navigate to Podman containers, expand 'Show images', and locate 'docker.io/vaultwarden/server:latest'. Click the vertical ellipsis next to this, and choose Pull from the drop-down menu. If not, issue the following command from the Terminal:

```
podman pull docker.io/vaultwarden/server:latest
```

Once the image has been downloaded, recreate the container using your usual script—it'll immediately start using the latest version, and you should have access from Android (via a slicker user interface across all your devices to boot), again without any additional configuration required. You should also find your browser extensions magically update to provide you with the slick new Bitwarden interface.

Is Defender enough?

I've been using Bitdefender to protect my PC for years, and have never suffered from any malaware infection (that I know of). I was following Zak Storey's reinstall guide in the January 2025 issue and he suggests that Windows' own Defender tool is all that you need. Is this true?

— Jonathan K Hairston

THE DOCTOR RESPONDS: Zak is correct in suggesting that Microsoft's own Defender app offers perfectly good protection. It regularly scores highly in lab tests for protection, and offers all the core security you need. But it's not quite the full story. Defender is fine if you're naturally careful and don't actively expose yourself to potential threats through your online behavior, but if you're the kind of person who frequents torrenting sites or who happily visits malware-infested websites for reasons we shan't ask about, then it pays to consider other options.

Third-party tools invariably offer more proactive forms of protection against malware—taking your copy of Bitdefender, for example, it comes with its own two-way firewall. While Windows' firewall can technically be configured to monitor outbound traffic, it's not configured to do so by default. This means it waves through any network requests from programs installed on your PC, while the firewall in Bitdefender Internet Security, although invisible by default, does at least create rules for apps—you can view (and amend) these via Protection > Firewall. You can also manually approve all app requests: switch to the Settings tab and flick the 'Alert mode' switch to On.

Bitdefender also offers protection against ransomware through its Safe Files feature, which can be configured to prevent apps from accessing or modifying files in key locations. You'll also find tools to protect online financial transactions, block online trackers, and prevent your webcam from being hijacked. Do you need all these features? If not, then Defender is sufficient. Otherwise, a third-party tool is a sound investment.

Windows stuck off-screen

Don't ask me how, but every time I open Word, it places the window partly off-screen to the top and left. This means I can't access the top bar to drag it back into place. Is there a way to fix this?

— Carolyn R Harrington

THE DOCTOR RESPONDS: There's no obvious reason why this occurs—you'd think Windows would make it impossible to place a window in this way. Thankfully, there's a quick and easy fix that will come naturally to you in future. Press Win + Tab to bring up the Task View, then right-click on the offending application window where you'll see options to Snap Left or Snap Right. Choosing either will make Word's window fully visible again plus fix its position for the next time you open it. ⏻

UNOBTAINIUM

More elusive than Bigfoot, and more powerful than Zeus's lightning bolt, the RTX 5090 is here

THIS IS TOO MUCH. It is. This launch is unlike anything we've seen. There are no excuses that can be bandied around here—no chip shortages, no logistical woes to worry about, or Covid working from home demand. This is just pure madness. Pure desire. Pure, unadulterated power—if you can find one, at least. We are, of course, talking about Nvidia's latest flagship GPU.

The RTX 5090 has finally 'launched' across the globe, and the demand has been phenomenal. The availability is extraordinarily low. Right now, you can't even pre-order the thing in most continents; some sellers have stock ETAs of up to 16 weeks.

It's understandable, to an extent. Nvidia's 50 series, based on the Blackwell architecture, on paper sounds like a phenomenal step-up in overall performance, delivering an unprecedented leap not only in terms of DLSS performance, but also in overall design. Although still on TSMC's 5nm process, overall die size has increased by 23 percent alone over last gen, bringing with it over 21,000 CUDA cores and 170 ray tracing cores. And of course, 32GB of absolutely speed-limit-breaking GDDR7 memory, too. It ain't no slouch.

Luckily, we managed to get our hands on one of the few RTX 5090s roaming around in the wild, and with it in hand, we knew we had to put it to the test. Not only to see how it performed, but if it was as power-hungry as the rumors had it. What exactly can this anathema to reason really do? **–ZAK STOREY**

BENCHMARKS

Part		Price
CPU	Intel Core Ultra 9 285K	$600
Motherboard	Gigabyte Z890 Aorus Elite WiFi 7 Ice	$260
CPU Cooler	360mm Phanteks Glacier One 360D30 AIO	$170
RAM	64GB (2x32GB) TeamGroup T-Create Expert DDR5 @ 6000 C34	$166
SSD 1	2TB Seagate FireCuda 540 M.2 PCIe 5.0 SSD	$230
SSD 2	1TB WD Black SN7100 M.2 PCIe 4.0 SSD	$85
GPU	Nvidia GeForce RTX 5090 Founders Edition 32GB	$2,000
Case	NZXT H7 Flow Black	$120
PSU	1200W NZXT C1200 80+ Gold	$259
Fans	3x Phanteks D30-120 RGB Fans - White	$90
Accessory	NZXT Vertical GPU Mounting Kit	$80
Total Price		**$4,060**
Core Price*		$3,326

*"Core Price" refers to the key components generating performance (CPU, GPU Mobo, OS SSD, RAM), not accessories. GPU price based on RRP at time of initial launch.

PRICES CORRECT AT THE TIME OF PUBLISHING

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STEP-BY-STEP GUIDE PG.22

CPU $600

Intel Core Ultra 9 285K

Intel's latest gen CPUs got a lot of heat when they debuted, thanks to their rather underwhelming performance, numerous bugs, and poor resource allocation. Combine that with similar gen-on-gen pricing and fewer threads, thanks to the removal of hyper-threading, and it seemed like a recipe for failure.

Fast-forward a few months, and things are starting to change. With the Core Ultra series now having an armada of BIOS and Windows updates backing it, the question is, does it hold up today compared to its Team Red competition?

Cold hard facts? $600, 24 threads, eight performance-cores, 16 efficient-cores, 5.7GHz max turbo frequency, and 36MB of smart cache, with a max power draw of around 250W. **www.intel.com**

INTEL CORE ULTRA 9
285K
SRQD5
L434G459

Motherboard $260

Gigabyte Z890 Aorus Elite WiFi 7 Ice

A cheap(ish) Z890 board? Can we believe what we're seeing!? Yes, thankfully, we can. That's a clean-looking sub-$300 Z890 board, complete with multiple M.2 slots, including PCIe 5.0 support, a 16+1+2 power phase design, plenty of juicy connectivity, and a decent enough rear I/O (admittedly a little low on the USB side of things featuring only nine of them, four of which are 2.0). More impressively, it's completely white, giving us a really clean look for our (mostly) white system.

Although it feels like there's not a huge amount to discuss here, for the cost, there are actually quite a lot of neat features that Gigabyte has included. The reinforced top-most PCIe 5.0 x16 slot is luscious, and controlled by a push button on the far right of the board. The M.2 heatsinks are held in place with latch tech, and the WiFi 7 antenna is a plug-and-play solution as well. Compared to ASRock's Z890 solution, it's night-and-day different. This is particularly impressive, given the cost disparity between the two. www.gigabyte.com

STEP-BY-STEP GUIDE PG.22

RAM $166

64GB (2x32GB) TeamGroup T-Create Expert DDR5 @ 6000

We've played around with some seriously quick RAM kits lately, including Corsair's wild 8,000 MT/s kit. Although they do lead to some impressive performance metrics for your rig, their real-world application feels a little lackluster, even for us. To that end, we've decided to pivot away from frequency, instead opting for capacity.

TeamGroup's T-Create Expert DDR5 fits the bill. Not only is it incredibly affordable at just $166 for a 64GB kit @ 6000 MT/s, but it's also pristine white, with no RGB, which honestly feels like a positive these days. The heatspreaders are slick, low profile, and generally look top-class. Plus, that white finish will fit our overall theme quite nicely.

www.teamgroupinc.com

TC
T-CREATE
DDR5
EXPERT

CPU Cooler $170

360mm Phanteks Glacier One 360D30 AIO

For our cooling solution, we've gone for an old and affordable favorite in the form of Phanteks' Glacier One 360D30 AIO. This isn't the first time we've used it, but it left such an impression on us thanks to its compatibility, ease of use, and 'no frills' approach to design that it made the perfect pick for this rig, too.

Performance is still top-notch thanks to that AIO design and 360mm rad, and Phanteks has bundled this with a triple set of its daisy-chainable D30 fans, again all in white, and rip-roaring along at comfortable enough speeds to keep that heat buildup at bay.

There are definitely slicker AIOs out there, but this is a fantastic pick if you're on a budget, and don't want to compromise on your CPU cooling performance.

www.phanteks.com

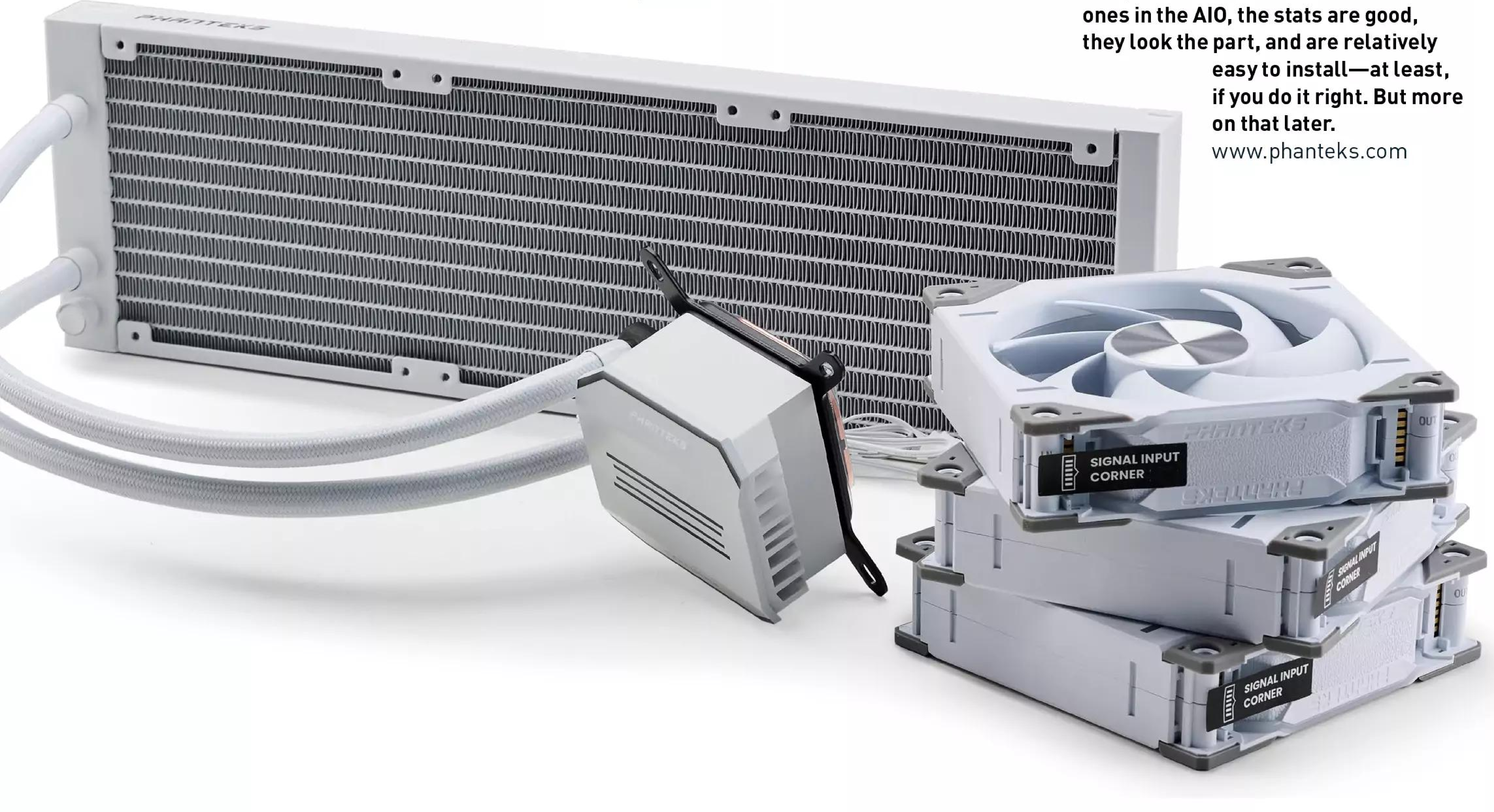
Fans $90

3x Phanteks D30-120 RGB Fans - White

Because of the power draw and monstrous size of the GPU die, adding a set of backup fans to keep this thing cool was a necessity. In fact, the H7 Flow is almost purposefully built with this in mind, with a 3x120mm recess located at the bottom of the case.

To match our AIO fans, we grabbed another set of Phanteks' D30 RGB daisy-chainable fans. Identical to the ones in the AIO, the stats are good, they look the part, and are relatively easy to install—at least, if you do it right. But more on that later.

www.phanteks.com



FIRECUDA
SEAGATE
WD_BLA
SN71

GPU $2,000

Nvidia GeForce RTX 5090 Founders Edition 32GB

This GPU has had a heck of a price bump over the RTX 4090, but Nvidia argues for good reason.

Although based on the same process, total die area has increased dramatically, with CUDA cores shooting up from 16,384 on the 4090 to a whopping 21,760 on the 5090. Similarly, Tensor cores are at 680 vs 512, ray tracing cores are up from 128 to 170, and the memory has gone up from 24GB of GDDR6X to 32GB of GDDR7, skyrocketing bandwidth from 1,008 GB/s to 1,792 GB/s.

The downside? Aside from the $400 increase, it now has a TDP of 575W as standard. Nvidia, by default, recommends a minimum PSU spec of at least 1,000W, and even PC Part Picker clocks our total build up at the 900W mark. If you already meet that mark, you don't need a new PSU, as it utilizes the same 12VHPWR cables, although the internal power interface has been redesigned. It's now listed as 12V-2x6. www.nvidia.com

Accessory $80

NZXT Vertical GPU Mounting Kit

To really make our build shine, we've grabbed one of NZXT's vertical GPU mounting kits. Technically, this isn't 'compatible' with the latest H7 series case; it just needs a little love and a few mods. But it lets that GPU sit sideways, and we're big fans of that.

Additionally, it only comes with a PCIe 4.0 cable as standard. We've tested the card with both the riser and direct, and haven't seen any major difference in performance. Arguably, the CPU is now the limiting factor for the bottleneck rather than the bandwidth on that slot, so we wouldn't worry too much. NZXT also sells this in either black or white to match your chassis. Neat. **www.nzxt.com**

PSU $259

1200W NZXT C1200 80+ Gold

On paper, a 1200W PSU should fit the bill. Nvidia recommends an ATX 3.0 unit at a minimum, plus 1000W of power. As the C1200 is a mighty power supply unit capable of delivering that kind of wattage, and comes with a 12VHPWR direct cable as standard, it made sense.

Within minutes of the first benchmark, the meter read a staggering 850.4W. The worst part? It was *Final Fantasy XIV*—not even a serious, arduous rendering test.

Despite the immense load we placed this machine under, the C1200 held its ground, albeit with one caveat: we did get some noticeable coil wine on the card itself. We've tested it with a few PSUs, and this does seem to be related to the card, rather than the power supply, but some PSUs do seem better equipped at handling that noise. We're investigating, and will update once we fully understand the issue. **www.nzxt.com**

40 Series
Cle Gen5 SSD
1TB

SSD 1 $230

2TB Seagate FireCuda 540 M.2 PCIe 5.0 SSD

It feels wild to say this, but we've not actually used the Seagate FireCuda 540 as our primary OS drive since we updated to the new benchmarking scheme in September last year. That's wild, because this thing is an exceptional pick. Alright, it's not the fastest PCIe 5.0 drive out there, and relatively speaking, it is starting to get a little old, but Seagate's propping this thing up with some seriously decent features that are well worth mentioning.

Top-line specs are a Phison E26 controller paired with Micron's 232-layer TLC NAND flash and a healthy dose of LPDDR4 DRAM cache as well. Advertised speeds land well within the 10 GB/s mark on both read and write, but the big wins actually lie on endurance and warranty. You do get the standard five years, of course, but more impressively, Seagate has rated this thing at 2,000 TBW; compare that to the equivalent from Crucial, Corsair, Gigabyte, et al, and it beats them all by a comfortable 800 TBW. It also comes with Seagate's Rescue Data Recovery service as standard, so if it's damaged in flood, fire, or natural disaster, Seagate will try to recover the data for you. www.seagate.com

SSD 2 $85

1TB WD_Black SN7100 M.2 PCIe 4.0 SSD

The newest kid on the block, our WD_Black pick here was a bit of a last-minute decision on whether or not to include it. Initially it was going to be our OS SSD of choice, followed up by an SN5000 4TB for the back-up drive (in fact, this was such a last-minute decision you'll spot it later in this feature). In the build, we initially installed this as the primary drive, but it just didn't feel right pairing the 5090 with it. Still, we were curious how it held up under load, so it's been shuffled into the secondary SSD position in the rig.

It's a curious little number, too. Very similar in performance to the older SN850X, but with a newer Kioxia 162-layer TLC flash, and likely the same controller found in the SN5000. There's no DRAM cache on this one, but thankfully it's a single-sided design. **www.westerndigital.com**

STEP-BY-STEP GUIDE PG.22

Case $120

NZXT H7 Flow Black

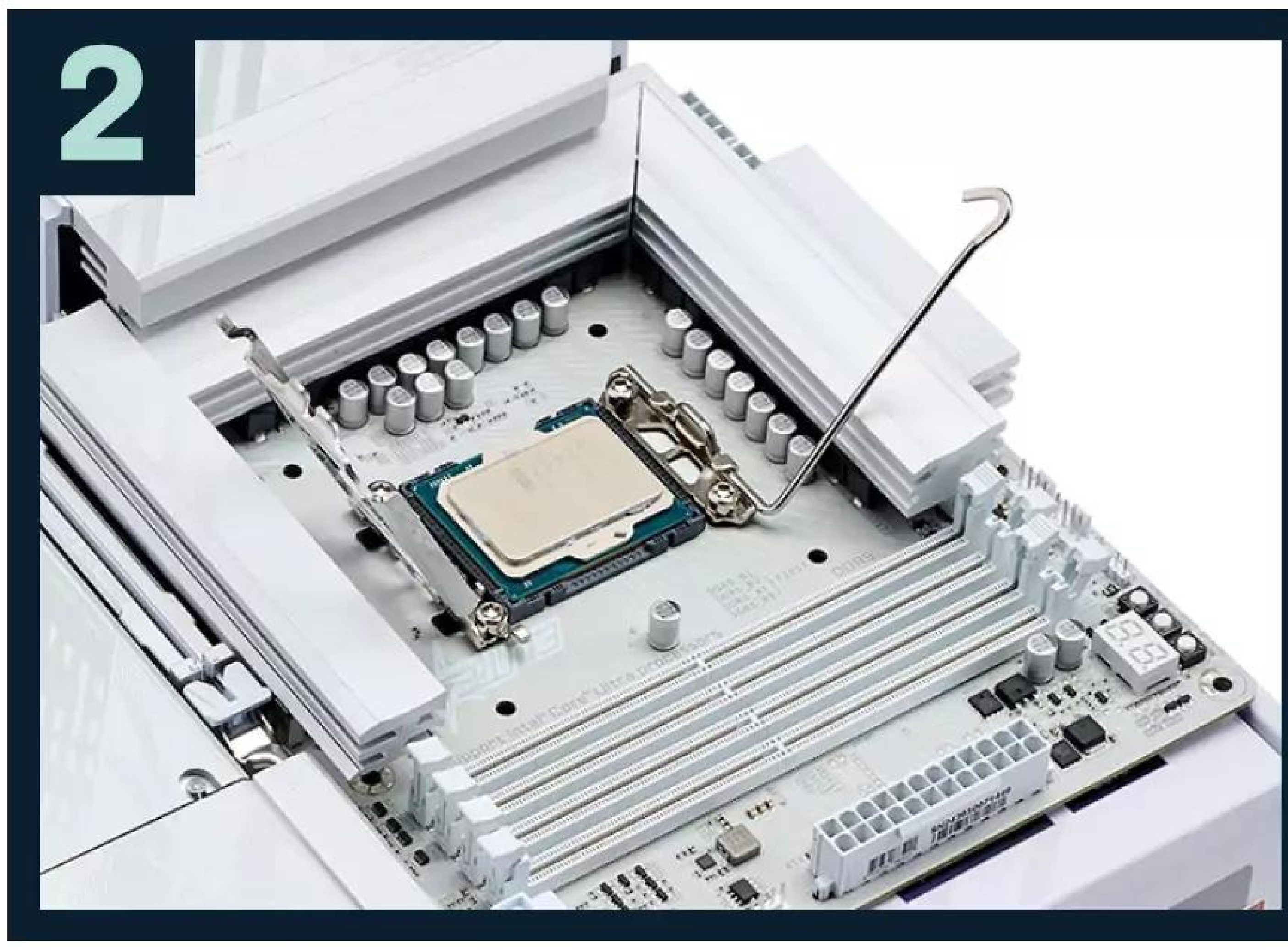
Tried and true, NZXT's H7 Flow is a fine chassis for those looking to build an ATX flagship system. Not only does it come in at a respectable $120, it also delivers some impressive cooling capacity, with support for up to 10 fans in total: three in the floor, three in the roof, and three in the front (at least at 120mm).

Combine that with expert cable management, good airflow, and plenty of neat little features to make your build go smoothly, and it's a worthy chassis for any RTX 5090 build. If you're not replacing the bulk of the fans like we are, opting for the RGB variant and grabbing a few of NZXT's latest RGB Core Frames instead is equally a valid solution.
www.nzxt.com

JUMPING TO LIGHTSPEED

1

2



3

LENGTH OF TIME: **1-2 HOURS**
LEVEL OF DIFFICULTY: **MEDIUM**

RIGHT THEN, that's enough of that. Yes, we all know; big card, very expensive, hard to get. But that's not just what these builds are about. They're about the build itself; the process, and the vim and vigor required to create a system that really ticks all the boxes for you. They're about taking you step by step through that process, and showing you that it's not as hard as some of the pros make it out to be.

As you've probably established by this point, the whole premise behind this system was really getting to grips with the RTX 5090 in a build environment. How does it fare? What's it like to handle? What considerations do you need to make?

It's that very thought that started this whole process, and why we decided to go with the NZXT H7 Flow as our base for the whole thing. Admittedly, this is a case we've used previously, and it's that experience with it in particular that made us choose it once again (albeit in a slightly different colorway). It's spacious, with plenty of cable management and ample cooling support; that'll be more than enough to ensure our RTX 5090 is well taken care of.

Case aside, we're sure that the next question's going to be, 'Why the Intel Core Ultra 9?' Simply put, we chose it for two reasons. Firstly, we knew that the vast majority of media would be turning to AMD processors to test these cards, particularly given the poor reception Intel had at launch. Secondly, Intel has come a heck of a way since that ill-fated debut, and as we saw last month, the pitfalls and foibles it initially had have been corrected with BIOS patches and Windows updates. Single-core performance has improved radically over the last quarter, and we're finally at a point where we're comfortable with recommending these chips.

DIVING INTO THE BEAST

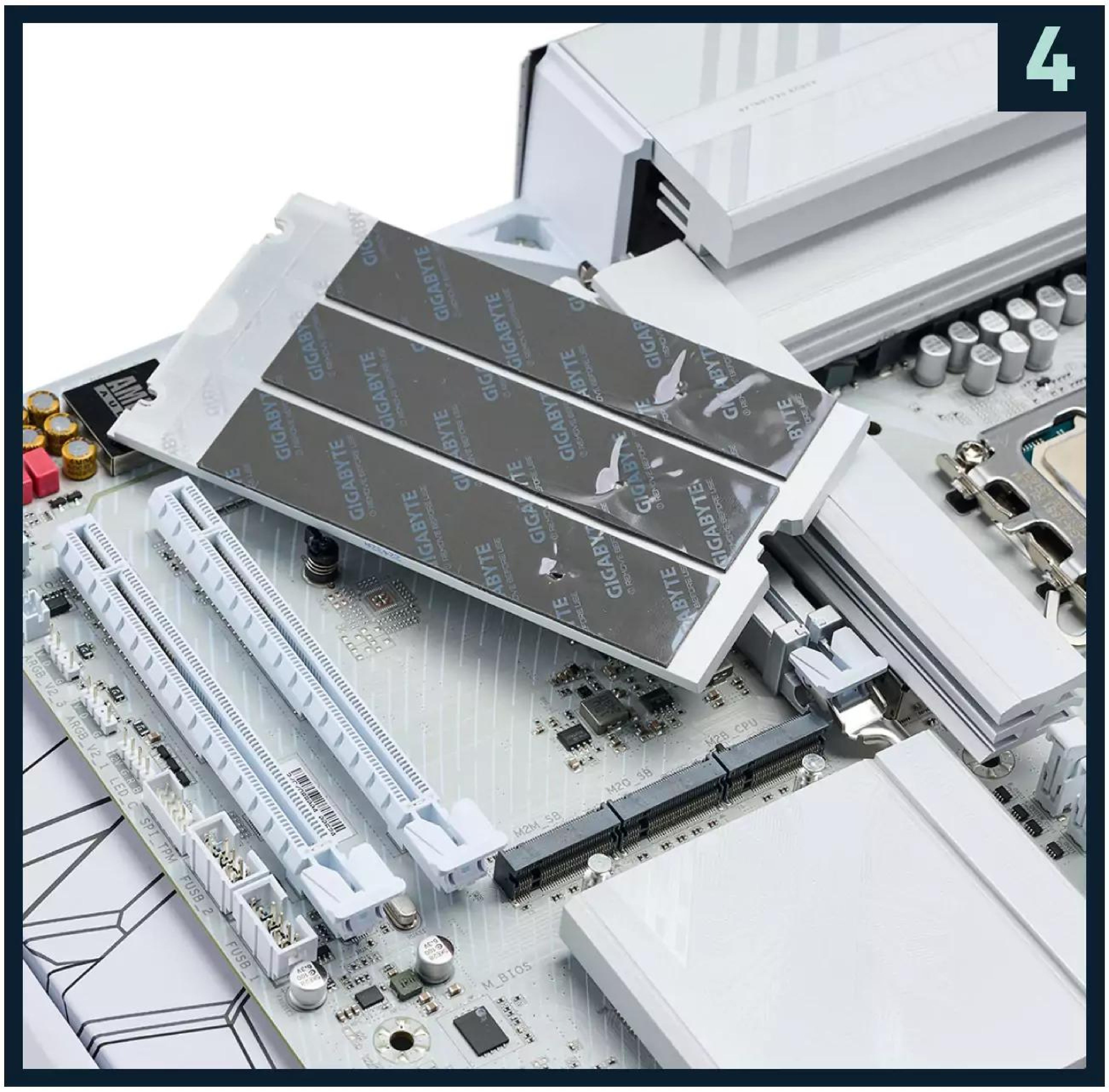
As always, even with a case that we've worked with previously, it pays dividends to remove as many panels as you can from your chassis. It's step number one in pretty much every build log we've ever written, and for a whole host of reasons. It protects the panels from damage and scratches, lightens the chassis, making it easier to shift around, and gifts you with better access to all of the internal mounting locations and awkward cable grommets.

In the case of the NZXT H7 Flow, pretty much everything is toolless. The top panel pops off from the rear, and the side panels have tabs that you can pop loose at the back of the case near the I/O. Once those two have been removed, you can finally remove the front panel by pushing forward at its edges.

There's also one additional internal panel worth removing, and that's the 2.5-inch SSD mount, located diagonally in the rear cable management area at the front of the case. A thumbscrew holds that in position, but it's worth chucking if you've long since departed the land of 2.5-inch drives, just to improve your cable management.

If you're replacing those front fans, it's also a great time to get rid of the stock ones that have been included. They're situated on a removable front radiator bracket, and cable-tidied pre-emptively into the rear of the case **STEP 1**.

With the chassis carefully torn apart and the panels stored, it's time to move onto the motherboard. Take the mobo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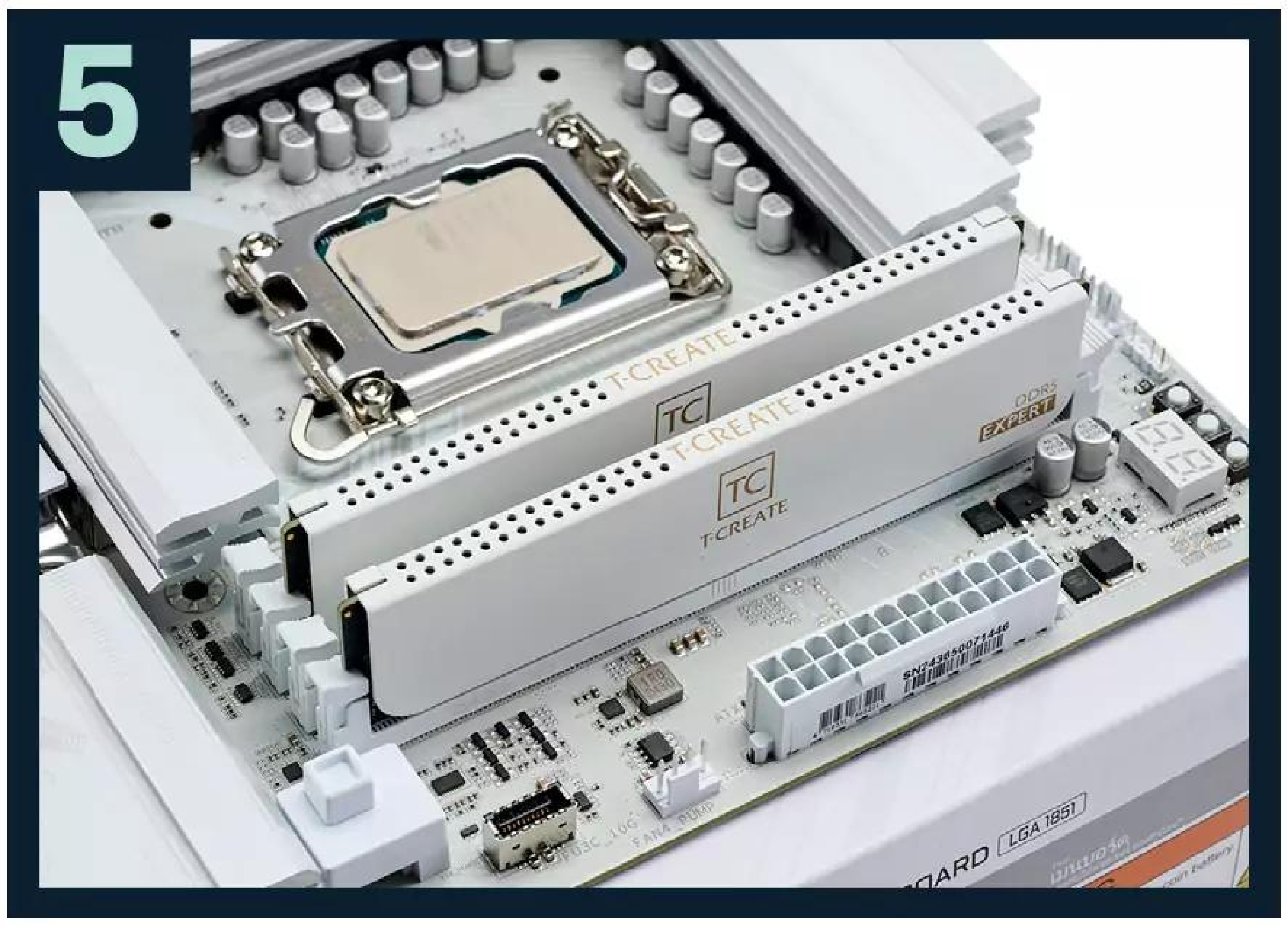
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out of its product box, remove it from the anti-static bag, and place it on top of the cardboard box itself (this helps to protect it from any static that's discharged).

First, we're going to install the CPU. You can do that by lifting the retention arm out to the side and then up; this will pop up and allow you to lift the CPU bracket. Once that's done, carefully lower your Core Ultra CPU into position. Intel's latest gen is using an LGA socket, so you'll have to be careful with the pins, but it's still fairly robust. Ensure you line the CPU's notches up with the socket itself (so the Core Ultra writing is in alignment with the top left of the board), and place it down. Then reverse the process, lowering the bracket and re-securing with the retention arm. Once done, the plastic cover will pop off **STEP 2**.

RE-JIGGING THE BUILD

With our CPU installed, it's time to move on to our storage. You can see that this is where we later make that SSD swap, post photoshoot, changing the WD SN7100 in favor of the Seagate FireCuda 540 as our primary drive **STEP 3**. In short, the M.2 heatsink is held in place thanks to this little latch; move that out of the way, and the aluminum heatsink can then be slid out.

Once out, carefully push your M.2 SSD into the header, ensuring you line up the notches, then secure it with the latch located in the port itself. With that done, remove the film from the top-most thermal pad, and re-secure into position. If you're ever in doubt about which slot is which on your motherboard, the M.2 slot closest to the CPU socket will almost always be the fastest one. This is logically done, as it reduces the physical distance the data has to travel to the CPU itself, improving latency as a result. It's a minor thing, but one that's consistent across all motherboard manufacturers.

With our primary drive in place, we can move on to our secondary solution. On the Z890 Gigabyte board, there are a batch of M.2 ports located below the primary PCIe 5.0 x16 slot, secured in place again by two pins, and a single latch on the other side. Move the latch out of the way, slide the aluminum block out, and you'll find three PCIe 4.0 M.2 ports ready for use. The topmost M.2 slot again is handled directly by the CPU itself rather than the serial bus, so if you're wondering which one to use, aim for the top-most one.

If you're worried about your M.2s getting hot and having a GPU so close to them, it's a worthwhile thing to think about. In our case, as we're using a PCIe riser, it's less of an issue, but without one, particularly hot cards in stuffy cases can cause problems in the long term, degrading performance.

Although NAND typically does benefit from being hotter, an SSD's controller (effectively a miniprocessor) does not. In some situations, it may be more beneficial to install a secondary SSD, further away from your GPU, to a port lower on the motherboard itself. This will theoretically lead to lower performance, but if it's a secondary SSD anyway, you're likely not going to notice, and the difference will most likely be imperceptible from day to day **STEP 4**.

MOTHERBOARD SCHMOTHERBOARD

With our storage in, it's time to get the RAM installed, too. Lift up the tabs on either ends of the slots (alternate slots, furthest away from the CPU), then carefully line up

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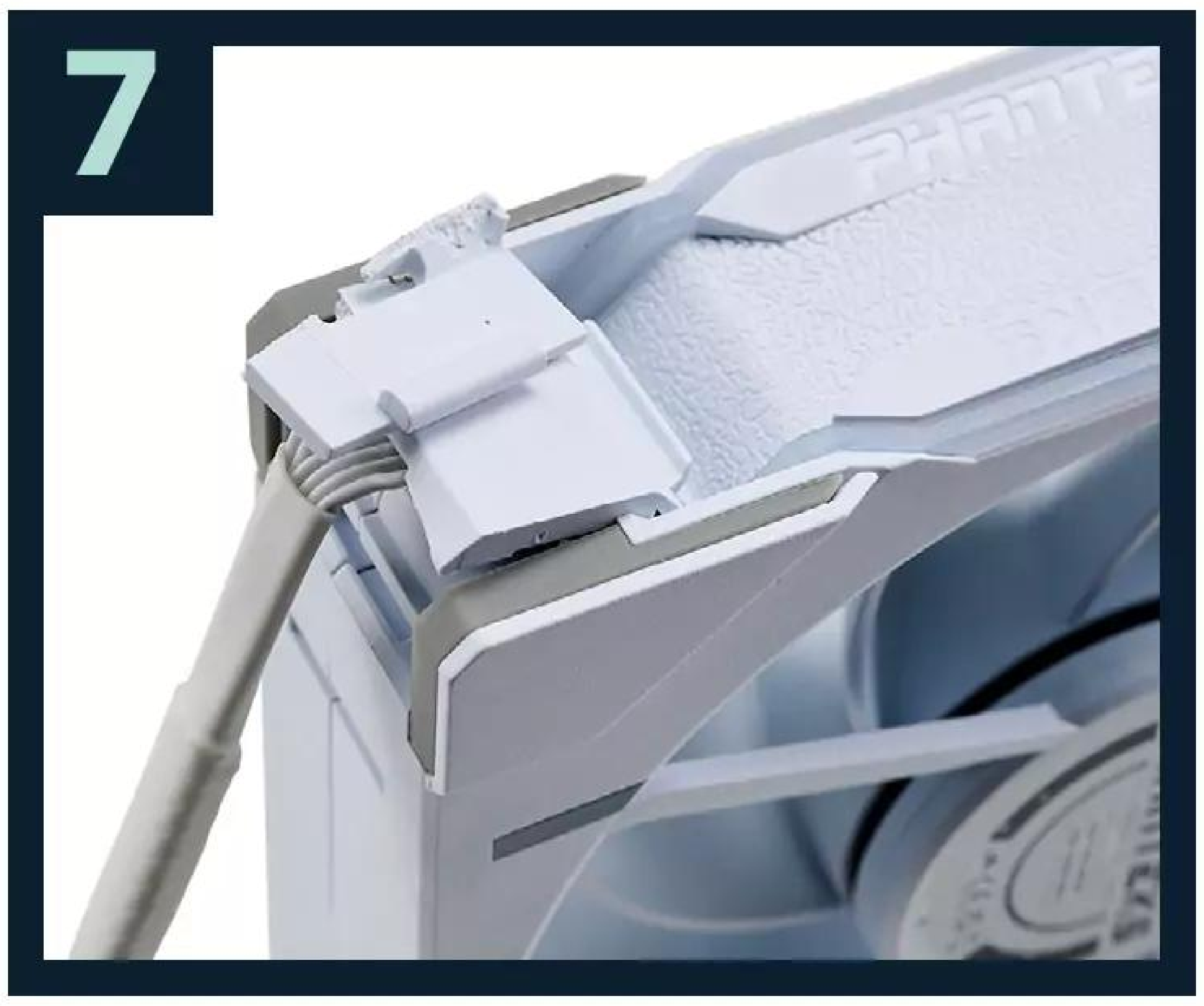

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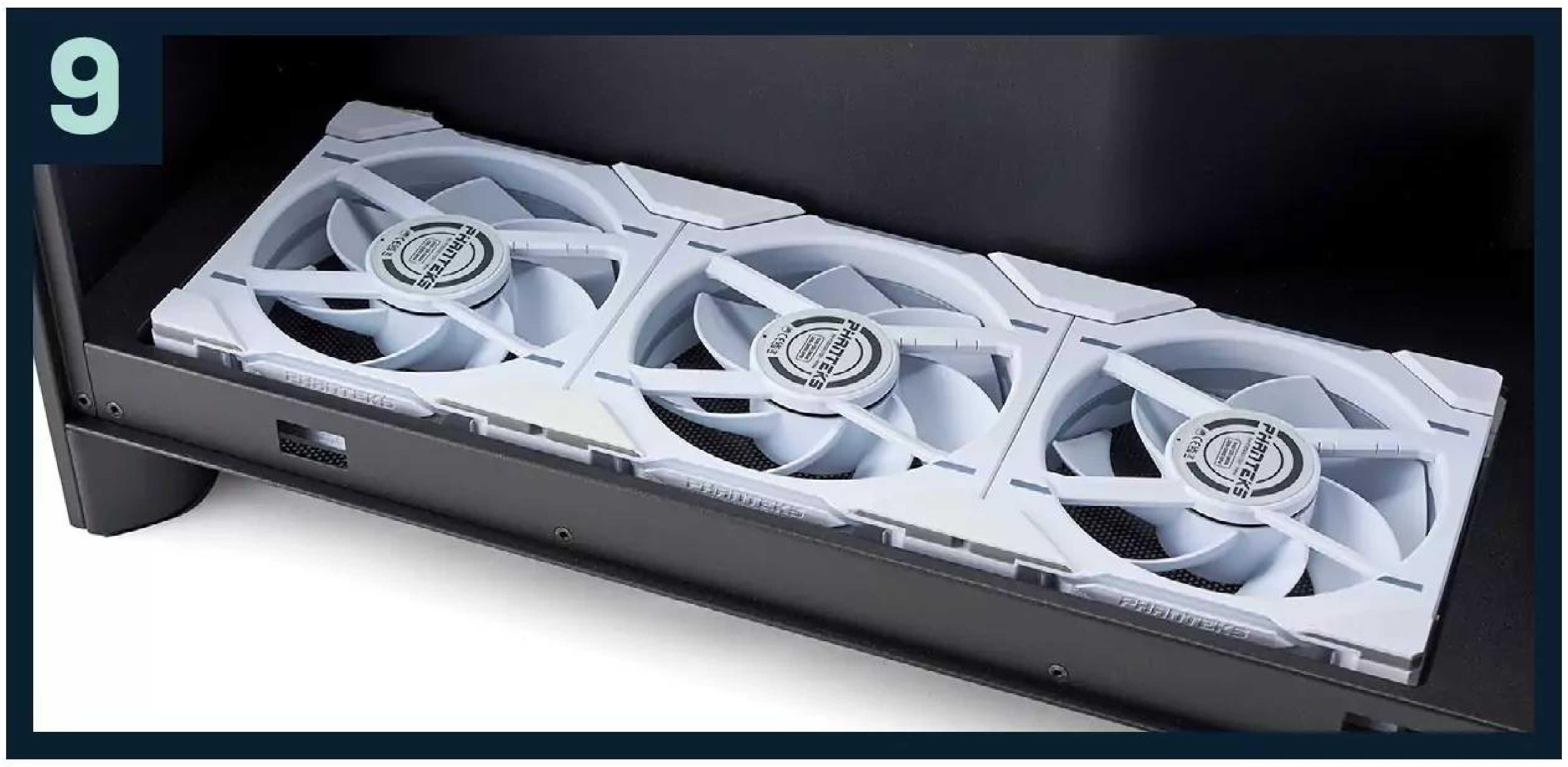

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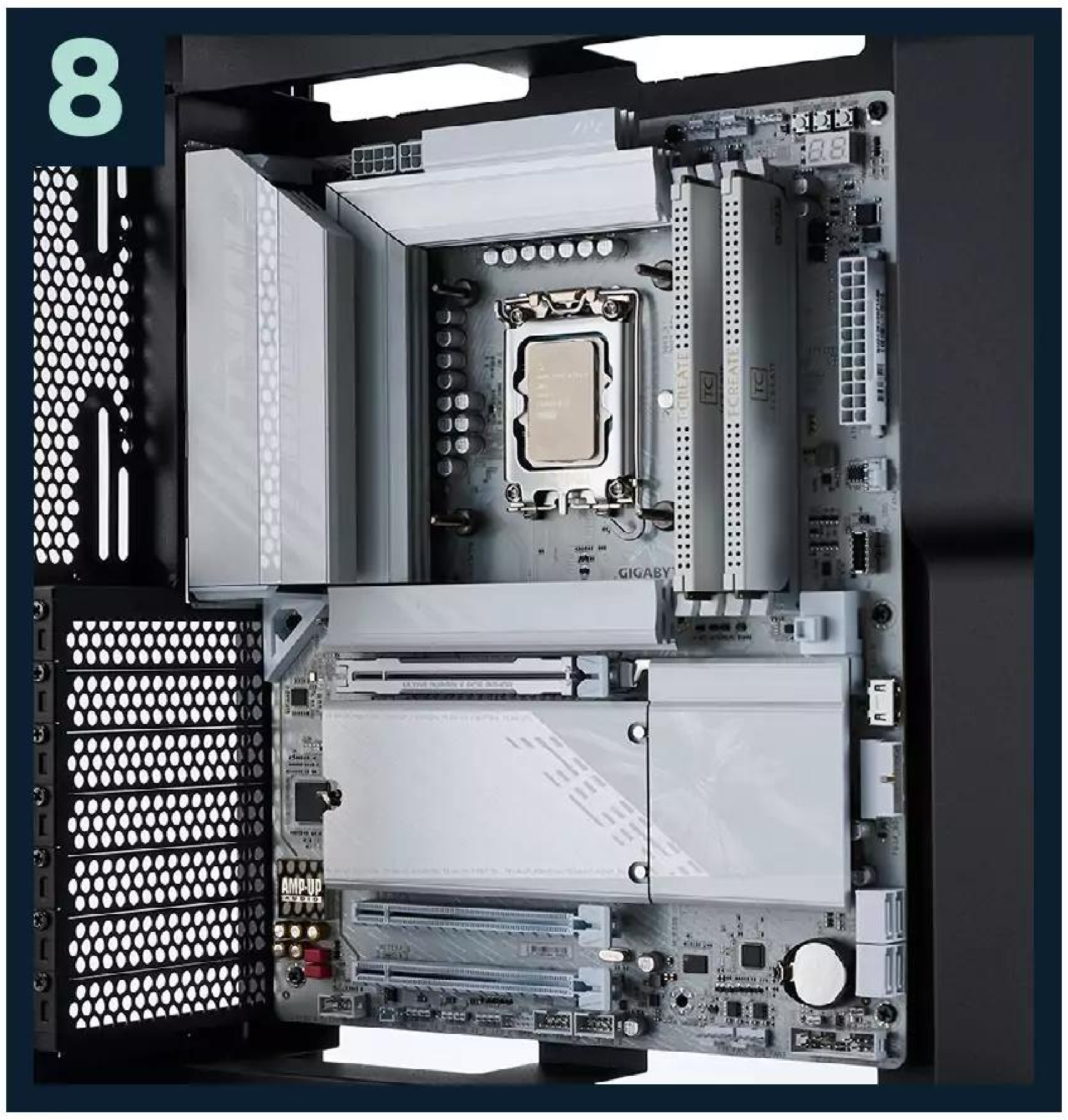

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the notch on the stick with the bump on the notch, and carefully press it into position, ensuring you push it down evenly at both ends at the same time. Once it clicks into place, you'll be safe in the knowledge that it's seated and secure **STEP 5**.

Lastly, we're going to get our mounting hardware into position. This Phanteks AIO has a super-smooth installation process, certainly for Intel. All you need are the four Intel stand-offs for LGA1851, happily available via a pre-labelled bag, plus the included backplate. Line the backplate up with the holes from the rear of the board, then place it back down on top of the box. Then, carefully install the stand-offs by hand, through the board into the backplate, until they're nice and secure. Word of warning: we've had trouble in the past getting these loose, so don't do them up too tightly **STEP 6**. And with that, we're all wrapped up with the mobo.

DISASTER

Let it be known, we dislike complicated plastic fan connectors here at *Maximum PC*. Disaster struck when we assembled our first set of D30 fans for use in the bottom; in short, we fractured the fan cable connector that attaches to the input side of the fan while trying to clip it into position **STEP 7**.

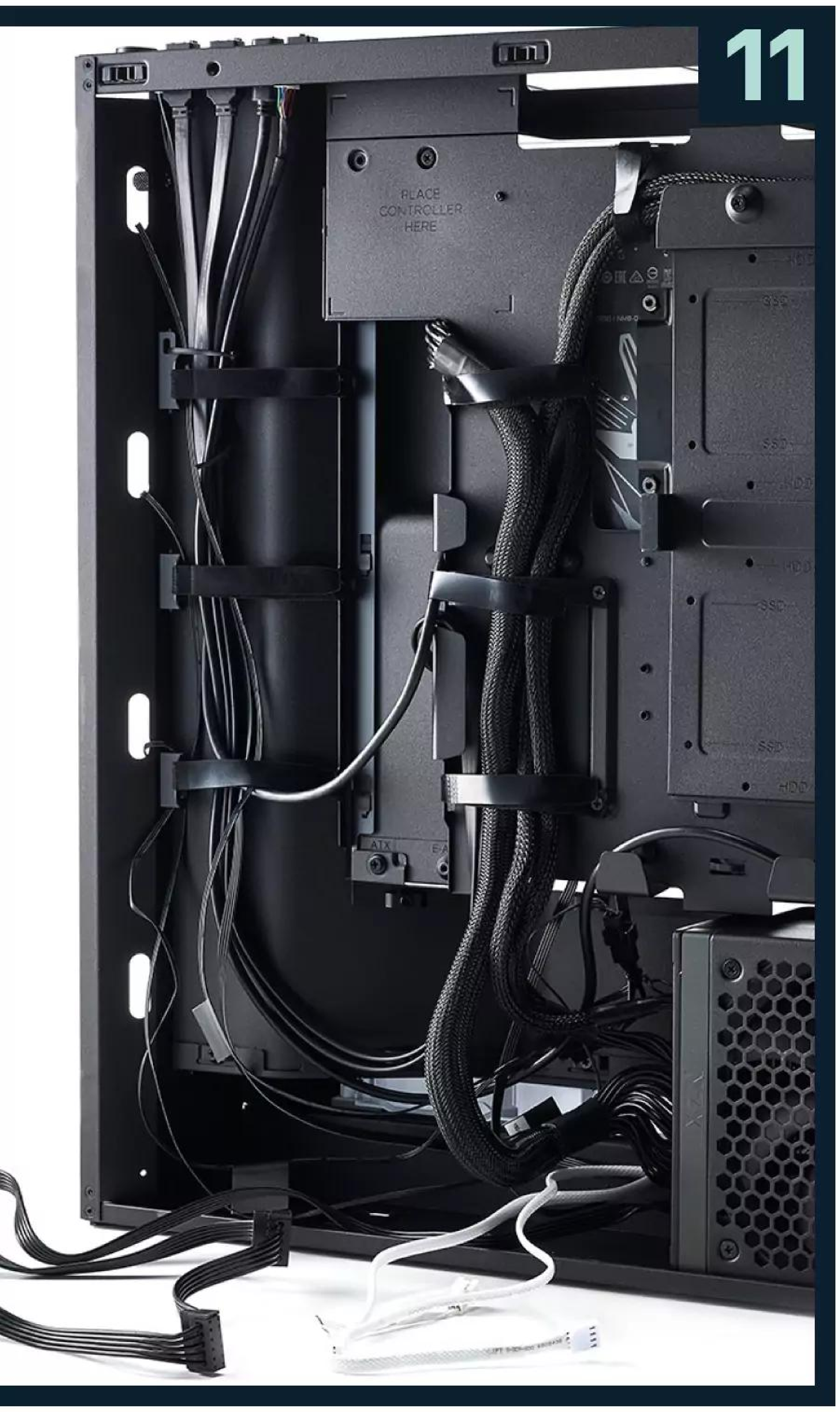
This is frustrating, as we were following the instructions, and weren't exactly giving it much force while trying to click it into position, yet nonetheless it broke. As these are entirely contact-based, however, rather than a pin connector or anything more serious, we took some white gaffer tape, and strapped the connector carefully to the fan before installing it later.

Fans aside, it's time to get the motherboard into the chassis. Lay the case flat down on its side, so the motherboard tray is facing up. Then carefully lower the board into position, slotting it over the motherboard stand-offs and into the rear I/O slot at the back of the case. Then, when fully positioned, grab the screws from the accessory box, and secure it in place. There are two screws available in the box; you want the ones without the flanged head. Secure the board down, ensuring these are tight **STEP 8**. Not only will this keep it safe during transport, it'll ensure you've got a good grounding between the board and the chassis (which is in turn grounded by the power supply).

With the motherboard in, we went about installing those bottom-most fans. The D30s fit snugly in the cutout at the bottom of the chassis. You can secure them in position from the underside of the case. You'll need to flip the case to access that, so it's best to do it immediately after you're finished installing the mobo. Be careful with your cable positioning here; make sure they point out to the back of the motherboard tray, and you'll be golden **STEP 9**.

POWERING THE BEAST

On to the PSU next. The H7 Flow supports rotated power supplies on this one, so there's no joy for the Corsair RMx Shift here. Still, NZXT's own C1200 fits a treat. We highly recommend installing the cables you need before you install the PSU into the case. It just makes it far easier to get access to those pesky,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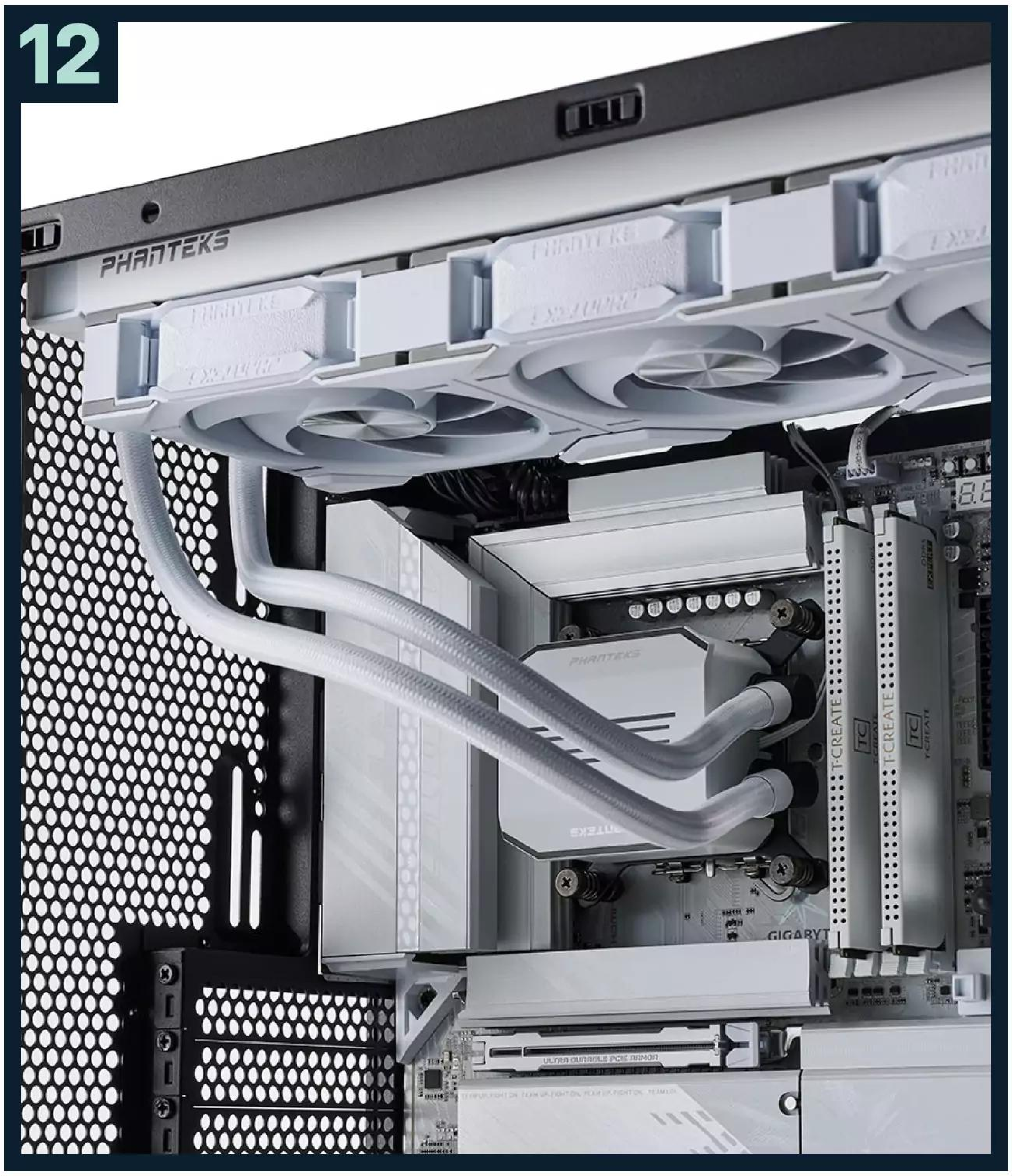
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often fiddly ports on the back of the unit. In our case, we know we're going to need a 24-pin, two 8-pin EPS connectors, and the 12VHPWR cable, and that's it. For good measure and future-proofing purposes, we're also chucking in a SATA power in case we add any fan controllers down the line, although you don't need to if you think that's unlikely.

With that done, slide the PSU into the case, secure it in place with the four included screws, and you're all set **STEP 10**. Next, we're going to start routing those cables. Take advantage of NZXT's cable management solutions now, because it'll make things way easier in the future. Getting the 24-pin in, the CPU power, and any front I/O connectors will make a world of difference. Use those velcro straps and channels to route the cables where you need them just to keep things tidy and ensure that the back panel fits nicely **STEP 11**.

Moving onto the cooler now, and Phanteks has done a stellar job on the design. It's super-easy to implement. It's worth installing the fans to the radiator outside of the chassis first. With the D series, connect them together with the included plastic clips, then mount them on the radiator, and install them with the long radiator screws. Then, once the screws are in, you can pop the plastic covers over them to give everything a really clean look. Finally, attach your input/fan power and RGB cable, and you'll be all set (or break it like we did a second time).

Then, lay the case back down on its side, and while you're holding the radiator to the top of the chassis, secure it with four screws—one on each corner—on the other side. Make sure you pick the larger flanged screws that fit the thread, and aptly secure them to the chassis itself. With that done, apply a line of thermal paste to your CPU (we recommend cleaning the stock stuff off the block), place the CPU block into position over the stand-offs, and secure with the included thumbscrews. Do this in a diagonal motion, one screw at a time: top left, bottom right, top right, bottom left. Do this slowly at first, a bit of thread each time. This is to ensure that we don't put too much pressure on just one side of the CPU, potentially damaging the socket or the chip itself.

With that done, pop the case back up onto its feet, and secure the radiator with the remaining screws. Then, thread the cables into the back of the case. Ensure you plumb the pump fan cable into the pump header (or CPU fan) on the motherboard, and do the same with the daisy-chained D30s. If you can, daisy-chain both the top and the bottom fans together, and tie them into the same RGB header located at the bottom of the board **STEP 12**.

BTF, EAT YOUR HEART OUT

We've plugged in as many headers as we can into the board itself, but unlike most of our systems, where we take the path of least resistance, we've opted to run the majority of the cables to the bottom of the board **STEP 13**. The ICE has a number of fan headers, USB headers, and RGB headers located on the very bottom of the motherboard. Now, we usually wouldn't do this, but as we're using a vertical GPU mount, all of this is basically going

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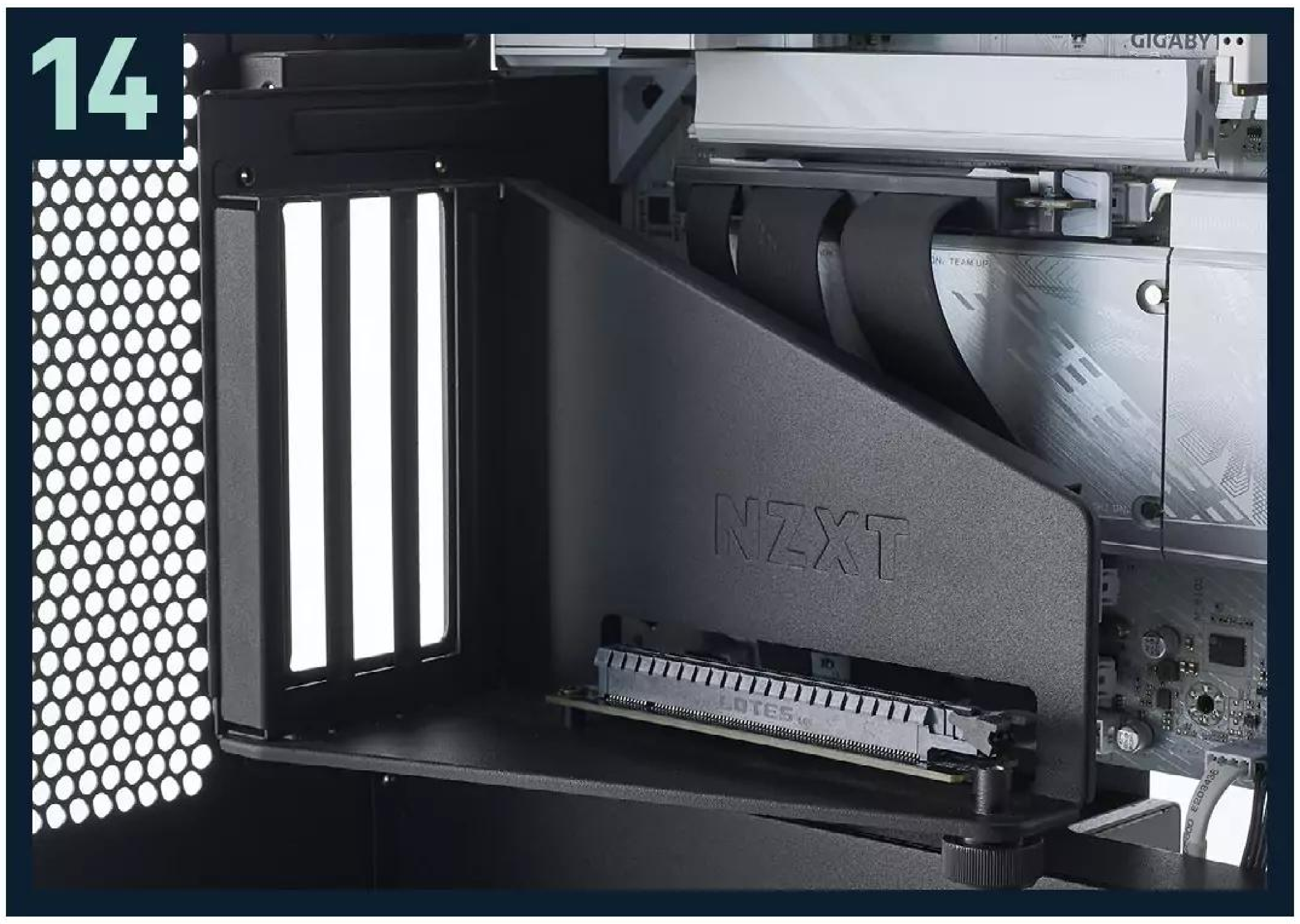

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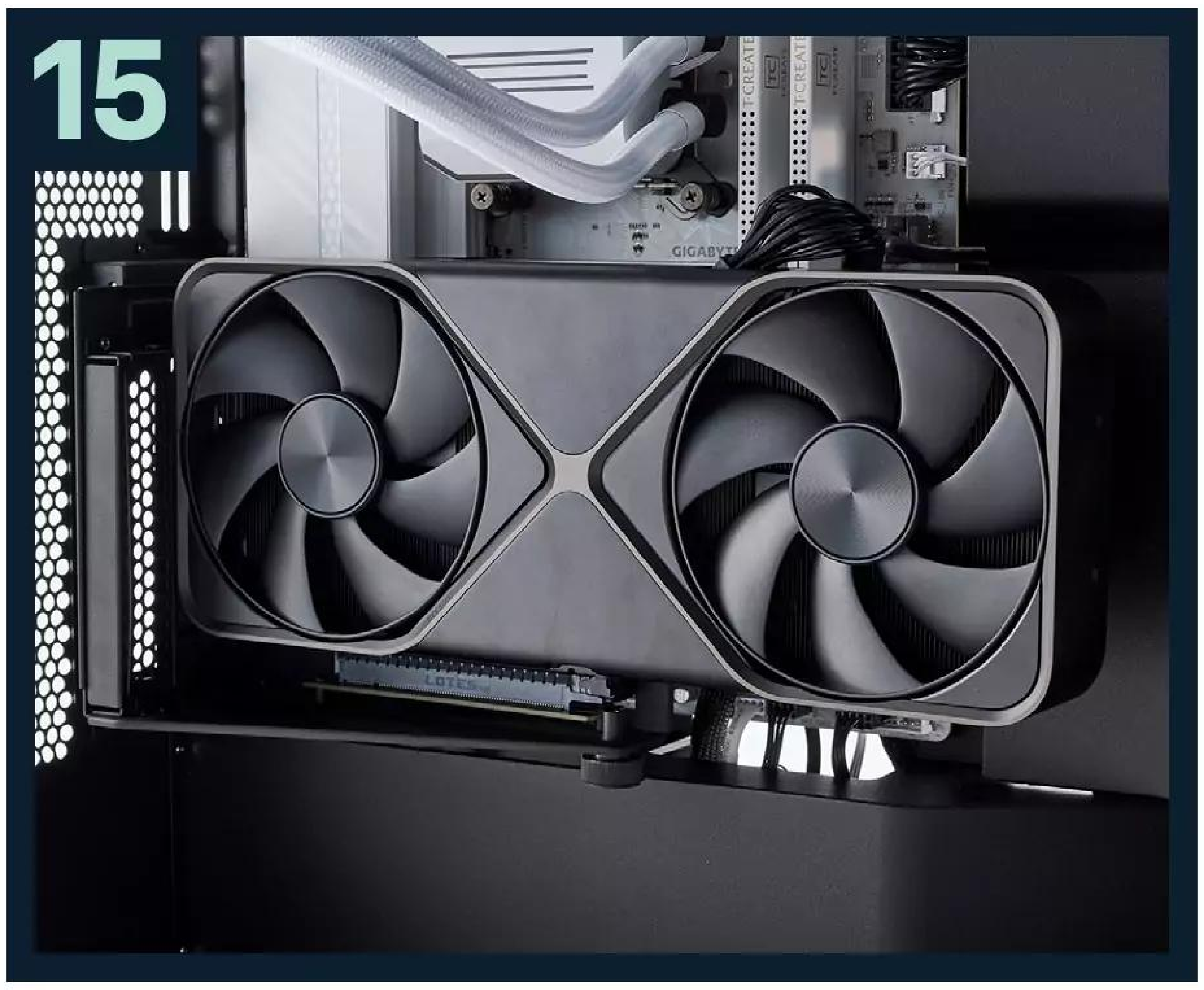


to be hidden, meaning you won't be able to see it or the godawful multi-colored HD Audio passthrough (why this is still manufactured like this, we'll never know).

So, our cables are installed, front I/Os are done, and our cooling is all sorted. Now it's time for the last piece of the puzzle, that mighty RTX 5090. In this rig, we're going to take advantage of one of NZXT's vertical GPU mounting brackets. Now let us be clear here: "Technically," this isn't meant to work in this case. NZXT would advise against it. As you can see from our beautifully captured image here (thanks Olly, **STEP 14**), on the bottom right of the bracket, there's a tiny adjustable foot that's meant to touch the bottom of the case. Because the H7 Flow has this deep recess portion, thanks to that right-angled PSU, and to allow for the inclusion of those bottom three intakes, this is just kind of floating. What that means is that if you install the bracket in place and a GPU on top, it might sag quite a bit, as there's no support there (thus the "it's not compatible, Zak" we received from our NZXT representative). Here's the thing, though: with a small amount of work, you can make it work.

First, take out all of the PCIe slot covers in the rear of the case. Then, slot your vertical GPU mounting kit into position over them, ensuring you click the riser cable into the top most PCIe 5.0 slot on the ICE motherboard. After that, secure the bracket into place with two screws (we found that the screws were a touch too short, so you might need to use force to get the thread to initially bite). With that, and those two screws, your bracket will be secure, albeit floating, and will work just fine **STEP 14**.

You can now take your nice, shiny $2,000 GPU that you just received on a 16-week back order and carefully slot it into position. Secure it down from the top (boy, it's nice the 5090 FE is a twin slot card), and push the power cable into position. At this point, you're technically done, but you'll notice that there's a bit of sag in the bracket **STEP 15**. It's less than ideal, so how do you get around it?

Well, once your system's positioned at home, take one of those PCIe slot covers you got earlier and position it so that the 90-degree end is on that bottom foot. Then, wedge it lengthways out behind the motherboard tray through the cable passthrough near those front I/O cables we installed earlier. With that done, you can turn or loosen the foot on the vertical GPU bracket. That in turn will put downward pressure on that metal slot cover, and force it to push up against the chassis itself. This will raise the vertical GPU bracket like a fulcrum against the motherboard tray. To be clear, this is not a secure solution, but it does effectively eliminate the sag and support the bracket more without looking too ghastly or waiting for NZXT to release a new vertical bracket for one case design in three years time, probably. Best of all, it looks really clean.

With that done, it's worth going around the back of the case, ensuring your cables are tidied and wrapped up in the correct positions **STEP 16**, and at last, you'll be finished. Then, it's simply a case of popping the panels back in, and you'll have a system that's ready to boot.

AFTER THE FACT

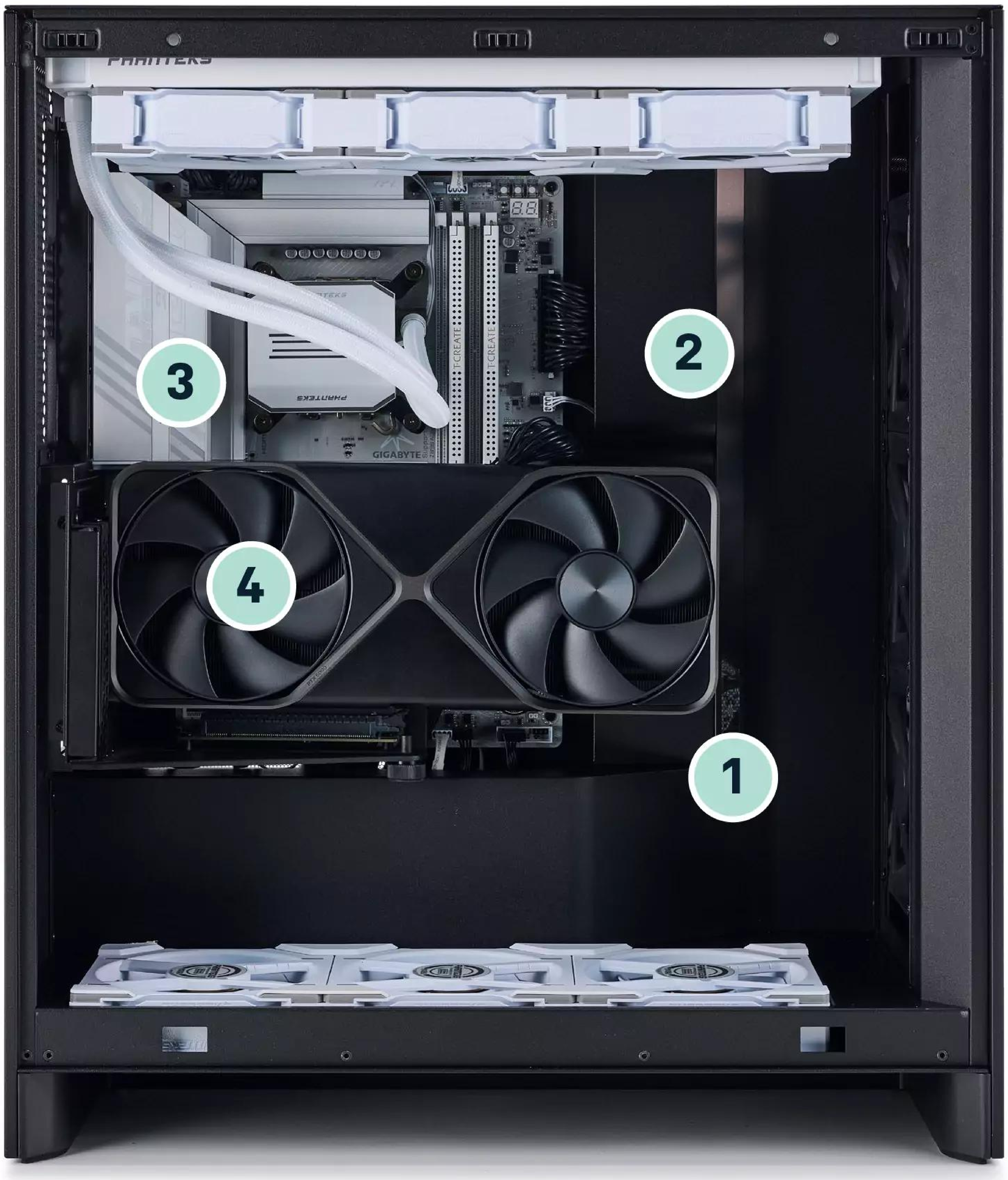
IF YOU'VE READ this far and you're looking at the annotations, you'll have realized that we made some pretty significant changes after the build was complete, namely swapping around the SSDs and adding a point of support for the GPU itself.

They're small changes, but they add up to a big result. The H7 Flow is a fantastically well built case. Too well built, in fact, but annoyingly, that angled PSU cover design does mean that a lot of those vertical GPU mounting solutions out there, even in NZXT's own arsenal, just aren't compatible with it. That's a problem, particularly as it's quite the trend at the moment. Plus, the internals on this thing are seriously impressive, and having a vertical GPU doesn't in any way stifle the GPU's intake fans. Combine that with the bottom-mounted case fans drawing a healthy dose of cool air up and into the GPU as well, and it's almost a no-brainer.

All in all, and aside from breaking the D30s (one set we broke on unboxing, the other while removing it from another build), little went wrong with the process. There's not a whole lot we'd change about the overall build. In hindsight, an all-white motherboard is quite an intense thing to look at in a system like this, and from a purely aesthetic perspective, a black solution would look better, but the value proposition that the Ice represents is just wild and hard to match, really.

Then there's the GPU. Although it's great that Nvidia has built this awesome twin slot card, this has to be one of the most mundane founder's edition designs we've seen for some time. It certainly doesn't compare to the likes of the last generation, or even the 10 or 20 series, sadly. That's a shame, because Nvidia's always had a bit of a style all its own. We wouldn't be surprised if that's due to Nvidia repositioning its marketing efforts more towards professional, creative, and AI workloads now rather than the gamers it used to target, as sad as that may seem. Still, the AIB partner cards are as weird and wonderful as ever (see our CES feature), and with plenty of triple slot solutions, there's all manner of designs you can sink your teeth into.

Of course, we need to mention the fact that we'd love for NZXT to have custom cable kits. We've spoken to them in-depth about it, and sadly, it seems that the only avenue you have is to go via CableMod or a similar custom cable solution if you're after something braided. This is honestly a shame, particularly given how classy these PSUs are.



1 This photo was taken before our vertical GPU mount/slot cover bodge, and you can tell the droop on the graphics card is a bit more severe than we'd like.

2 Sadly, NZXT doesn't have sleeved cables on its timeline, so if you're after a kit, you'll need to grab some from CableMod or a similar manufacturer.

3 An all-black motherboard would have really helped the contrast pop a bit more for this build. In hindsight, it's a bit of a regret.

4 Nvidia's RTX 50 series FE design has to be one of the dullest we've seen for some time.

MYTHICAL CREATURES

HOW WE TEST

At *Maximum PC*, we're big fans of tests, data, and numbers. It's a pivotal part of what makes this job so interesting. It's also a big part of how we hold this industry to account. Nvidia telling us that the RTX 5070 is equally as potent as a 4090 is all well and good, but unless that's proven, this is nothing more than a marketing pitch designed to get you to part with your hard-earned money.

With that in mind, every system we build here is put through a whole arsenal of tests to really get to grips with how it ticks and what performance it delivers. We cover everything: CPU performance, SSD speed, gaming, and AI. Basically, we cover pretty much everything we can, each and every time. A total of 98 test runs and metrics are measured and performed to get us all the results we need and deliver the ultimate analysis of the build and the parts in it.

THIS ISSUE'S ZERO POINT

For our zero point, we've gone with the same zero point we used in our November 2024 build, which was an Intel 14th Gen new microcode update. We picked this for one reason and one reason alone: the core price is about $600 off that of this build. That might sound like quite a steep jump (and it is), but it was the most expensive build we'd committed to this benchmark suite at the time of writing.

Our zero point, then, features the Intel Core i9-14900K, an Asus Z790 ROG Dark Hero, a Phanteks 360mm Glacier One 360D30 RGB AIO cooler, 32GB (2x16GB) of Lexar Thor OC DDR5 @ 6000 C32, a 2TB Crucial T700 M.2 PCIe 5.0 for the primary OS, a 2TB Kingston Fury Renegade PCIe 4.0 SSD for our secondary SSD, and a Gigabyte Aero OC RTX 4080 for our graphics card. All of this is housed nicely inside of Geometric Future's M4 chassis, complete with 1200W Corsair RMx Shift PSU and a triple pack of Phanteks M25-120 fans.

The total price for the Zero Point build at time of writing is $3,499 (16 percent cheaper), with a core price of $2,682 (21.4 percent cheaper than our RTX 5090 build).

ABSOLUTE 4K ANNIHALATION

In what will be surprising news to no one, the RTX 5090 is an absolute beast when it comes to our benchmarking suite. Not only does it dominate at 4K; it also eviscerates most of its predecessors in almost every other benchmark we can throw at it.

That said, it's not without its foibles, and there are a few outliers here and there that really drag the score down, perhaps a bit too much. Certainly at 1080p, this card just doesn't make sense at all. But interestingly, comparing our two zero points, you can see that *Far Cry 6* actually performed better under Intel's Core i9-14900K, with the new microcode and an RTX 4080 Aero OC, than the Core Ultra 9 285K and the 5090. We're still investigating why this is. There's a chance it could be resource mismanagement or some form of bottleneck occurring between the 5090 and its parent CPU processor here, but we are still none the wiser as to why that is.

Still, even with that outlier, the dominance this thing has at 1080p is frightening, with scores racking up close to an average of 226 fps. *Total War* in particular managed a blisteringly fast 303fps on average during its three test runs, with a minimum frame rate faster than most high-end gaming monitors.

However, it's the 4K results that really shine, and with an overall average frame rate of 142.9 across all four titles and five sets of tests, it's hard to deny just how potent this thing is. For years, journalists have jested about 4K gaming becoming a reality, with X, Y, and Z tweaks. Finally, 120fps is possible even on the hardest of titles, albeit it comes with a two-grand price tag.

Cyberpunk in particular, with ray tracing and no other DLSS shenanigans hit 56.6 fps on average; that is astounding, given how aggressive that game is on GPU hardware. Similarly, in its DLSS run (using stock frame gen settings), it more than doubled the overall performance compared to the RTX 4080 Aero OC, and that's without multi-frame kicking in via DLSS 4 as well.

AI PERFORMANCE

Sadly, we couldn't complete all of our AI testing using UL Procyon at the time of writing. We're still awaiting an update on the set of benchmarks for the RTX 5090, as currently we only have availability on AI Vision with Windows' ML API. That's not all bad, and the 5090 does put in a solid effort, even unoptimized, landing a score of 2,643 versus the RTX 4080's 1,902, but it's not the gangbuster numbers we'd expect from a card with this many Tensor cores.

The Nvidia TensorRT test is erroring on our version, so we can't report on that. However, the image generation test was wild compared to the 4080, with a score more than double its smaller gen.

A WORD FOR INTEL

Let's not forget the rest of the system. Intel's Core Ultra 9 285K does now look to be a pretty comfortable proposition for those interested in sticking with Team Blue. The 285K lands some respectable scores in Cinebench 2024, hammering the 14900K post-microcode updates with a 20 percent lead on the multi-core front and a nine percent lead on single-core. It's not wildly impressive, but we can see the performance improvements have been pretty numerous since its first launch, and that efficiency per thread and per watt really does shine through, with strong showings on the 'Per Thread' calculations.

We suspect that a lot of this is down to Intel letting the cores run a little looser on the voltage front, as this was the first time we saw the chips breach the 94.0 C mark, with the 285K actually clocking an impressive 101.0 C in HWMonitor.

WORTH THE WAIT?

So, is the RTX 5090 worth investing in? It's hard to say. This is a beast of a card that delivers some incredible performance, particularly at 4K and in certain AI workloads. The resources alone make it a tantalizing treat for those programs and applications that can really take advantage of it. But, and here's the kicker, the question has to be asked: is it good value for money? If you're looking at it with one task in mind—gaming, for instance—it's a challenging sell. Not only is it perpetually out of stock, but $2,000 for 4K 140fps is a big ask, and although it has finally broken down that barrier, that's a steep entry fee. Impressive? Sure. But worth it? Well, that depends.

SYSTEM BENCHMARKS

For our system testing, we use a multitude of separate benchmarks. For our CPU tests, these include Cinebench 2024 and Geekbench 6.3.0. All results are indexes in this case. Multicore per thread is achieved by dividing the total multicore scores by the number of threads on the CPU. For storage testing, we're taking advantage of CrystalDiskMark 8.0.5—the best scores are in bold, and all results are reported in MB/s. Throughout our entire benchmarking process, we test each system with a power meter plug running, and the latest version of HWMonitor installed and up as well. This allows us to report on the maximum power draw and temperatures seen over the entire benchmarking process.

CPU PERFORMANCE CINEBENCH 2024 & GEEKBENCH

	ZERO-POINT	
Cinebench 2024 Multi-Core	1,923	2,309 (20.1%)
Cinebench 2024 Multi-Core Per Thread	60	96 (60.0%)
Cinebench 2024 Single-Core	125	136 (8.8%)
Geekbench 6 Multi-Core	20,016	22,561 (12.7%)
Geekbench 6 Multi-Core Per Thread	625.50	940.046 (50.3%)
Geekbench 6 Single-Core	2,997	3,159 (5.4%)
		0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

STORAGE PERFORMANCE CRYSTALDISKMARK 8.0.5

	ZERO-POINT	
C: Sequential Read/Write Q8	**11,823 / 11,275**	9,974 / 10,038
C: Random 4K Read/Write Q1	63.04 / 301.83	**94.67 / 334.06**
D: Sequential Read/Write Q8	6,839 / 6,659	**7,106 / 6,932**
D: Random 4K Read/Write Q1	89.38 / **329.38**	**107.58** / 269.66

POWER DRAW & TEMPERATURE HWMONITOR & DEDICATED POWER METER

	ZERO-POINT	
Max CPU Temperature	100.0 C	101.0 C (-1.0%)
Max GPU Temperature	72.0 C	72.0 C (0.0%)
Max System Power Draw	618.2 W	850.4 W (-37.6%)
		0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

GAMING BENCHMARKS

Game tests are performed on Ray Tracing Ultra *(Cyberpunk)*, Ultra *(Far Cry 6)*, Maximum *(Final Fantasy: XIV Dawntrail)*, and Ultra *(Total War: Warhammer 3)* graphics presets. Three runs are performed per title, per resolution. *Cyberpunk* is always tested with ray tracing enabled regardless. Under its second set of conditions, DLSS/FSR/XeSS is enabled in *Cyberpunk* dependent on GPU manufacturer, with upscaling preset set Quality. Nvidia cards also have AI Frame Generation enabled. *FF XIV: Dawntrail* is utilizing FSR across the board regardless of GPU, with LOD on Distant Objects enabled, and dynamic resolution disabled. *Far Cry 6* is tested with DXR disabled, and the HD Texture pack downloaded and enabled.

1080P PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	85.2 / 68.9	**138.3 / 116.9**
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	202.4 / 157.9	**283.9 / 237.2**
Far Cry 6 (Avg/Min FPS)	**171.3 / 134.0**	159.0 / 120.7
Final Fantasy XIV: Dawntrail (Avg/Min FPS)	208.5 / **89.0**	**249.2** / 86.0
Total War: Warhammer 3 (Avg/Min FPS)	161.4 / 111.7	**303.2 / 183.7**

1080P PERFORMANCE

	ZERO-POINT	
1080p Titles Aggregate (Average FPS)	165.77	226.73 (36.8%)
1080p Titles Aggregate (Minimum FPS)	112.30	148.90 (32.6%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4K PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	26.7 / 17.6	**56.6 / 48.3**
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	75.7 / 39.2	**168.3 / 154.3**
Far Cry 6 (Avg/Min FPS)	108.3 / 76.7	**162.7 / 133.7**
Final Fantasy XIV: Dawntrail (Avg/Min FPS)	94.6 / 57.3	**162.9/ 86.0**
Total War: Warhammer 3 (Avg/Min FPS)	66.8 / 50.7	**164.1 / 123.0**

4K PERFORMANCE

	ZERO-POINT	
4K Titles Aggregate (Average FPS)	74.42	142.90 (92%)
4K Titles Aggregate (Minimum FPS)	48.30	109.05 (125.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

SYNTHETIC GAMING BENCHMARKS

We're using 3DMark's latest Speed Way, Steel Nomad, Night Raid, and CPU Profile tests. Speed Way represents a DX12 title at 1440p, with ray-tracing elements, Steel Nomad is DX12 4K without ray tracing, and Night Raid (DX12) is designed with integrated GPUs in mind at 1080p. CPU Profile acts as an additional CPU benchmark (reporting on max thread output only), with specific gaming workloads prioritized. Each synthetic test is run three times, and indexes are reported on.

3DMARK PERFORMANCE

	ZERO-POINT	
Speed Way (DX12 + RTX @ 1440p)	7,246	14,328 (97.7%)
Steel Nomad (DX12 @ 4K)	6,541	13,781 (110.7%)
Night Raid (DX12 @ 1080p)	95,238	101,073 (6.1%)
CPU Profile	15,312	18,339 (19.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

AI INFERENCE BENCHMARKS

For our AI testing, we use UL Procyon's Professional Benchmark Suite. We focus on its AI Computer Vision (which gives us a gauge on how our systems operate when dealing with inference engine tasks), and AI Image Generation benchmarks. For Computer Vision, we report on the total inferences performed, the average inference time, plus the Index score across all tests. The Index score is more valuable, as it's the time taken between inferences that indicates performance. We run all tests on AI Vision using Float16 precision. We test both the CPU and the GPU under Microsoft's ML API.

For Image Generation, we test under Stable Diffusion 1.5 (Float16 precision), using all engines available. However for comparison, we only include scores from the same engine. We report on the Index score, the time taken, and the image generation speed. All results are averaged across all tests. Best scores, where appropriate, are in bold.

AI COMPUTER VISION PERFORMANCE

	ZERO-POINT	
Microsoft ML API CPU (Index)	50	66 (32.0%)
Microsoft ML API GPU (Index)	1,902	2,643 (39.0%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Microsoft ML API CPU (Total Inferences)	10,284	13,830
Microsoft ML API CPU (Average Inference Time)	659.88 ms	**529.51** ms
Microsoft ML API GPU (Total Inferences)	226,692	248,780
Microsoft ML API GPU (Average Inference Time)	9.883 ms	**5.560** ms

AI IMAGE GENERATION PERFORMANCE

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Index)	2,616	5,955 (127.6%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Time Taken)	38.223 seconds	**16.791** seconds
Stable Diffusion 1.5 ONNX (Image Generation Speed)	2.389 seconds/image	**1.049** seconds/image

BEST OF CES 2025

PCs were the star of the show at this year's Consumer Electronics Show in Las Vegas. *Guy Cocker* was there to scout out the best CPUs, GPUs, laptops, and product concepts that should all be coming your way this year

WHAT A START it's been to 2025! No sooner had we gotten over our New Year hangovers, we found ourselves headed to Las Vegas to attend this year's Consumer Electronics Show—the biggest event of the year for new PC products. We touched on some of these last issue—most notably Nvidia's 50-series Blackwell cards, which finally arrived well over two years since the launch of the last generation.

We've barely been back a couple of weeks, and already we've seen the flagship card, the RTX 5090, go through our labs (see our verdict on page 74), be released, and then sell out. As we said, it's been a whirlwind!

Thankfully, it wasn't just new GPUs. The promise of AI over the last couple of years has now turned into tangible benefits. The handheld gaming PC market has continued to mature, with countless new models on show. And new CPUs, particularly in the mobile space, have us excited about a future where gaming laptops don't even need dedicated GPUs.

Here are the hottest products we saw at the show, the ones we've been dreaming about getting our hands on since we left Vegas, and what we'll be saving up to get our hands on for the rest of the year.

RAZER BLADE 16

This was the most alluring gaming laptop of the show. Not only is it a slimmer-looking, edgier-feeling machine, but it keeps the fantastic OLED panel from last year's model, while updating the hardware inside to include AMD's Strix Point chips in the CPU socket (all the way up to the Ryzen AI 9 HX 370) and RTX 50-series mobile GPUs. Razer also says it will be "aggressively priced", although what that translates to in practice remains to be seen.

- Out: Q1 2024 • www.razer.com
- Price: TBC

© RAZER, AMD, LENOVO, ASUS

NVIDIA RTX 5090 FOUNDERS EDITION

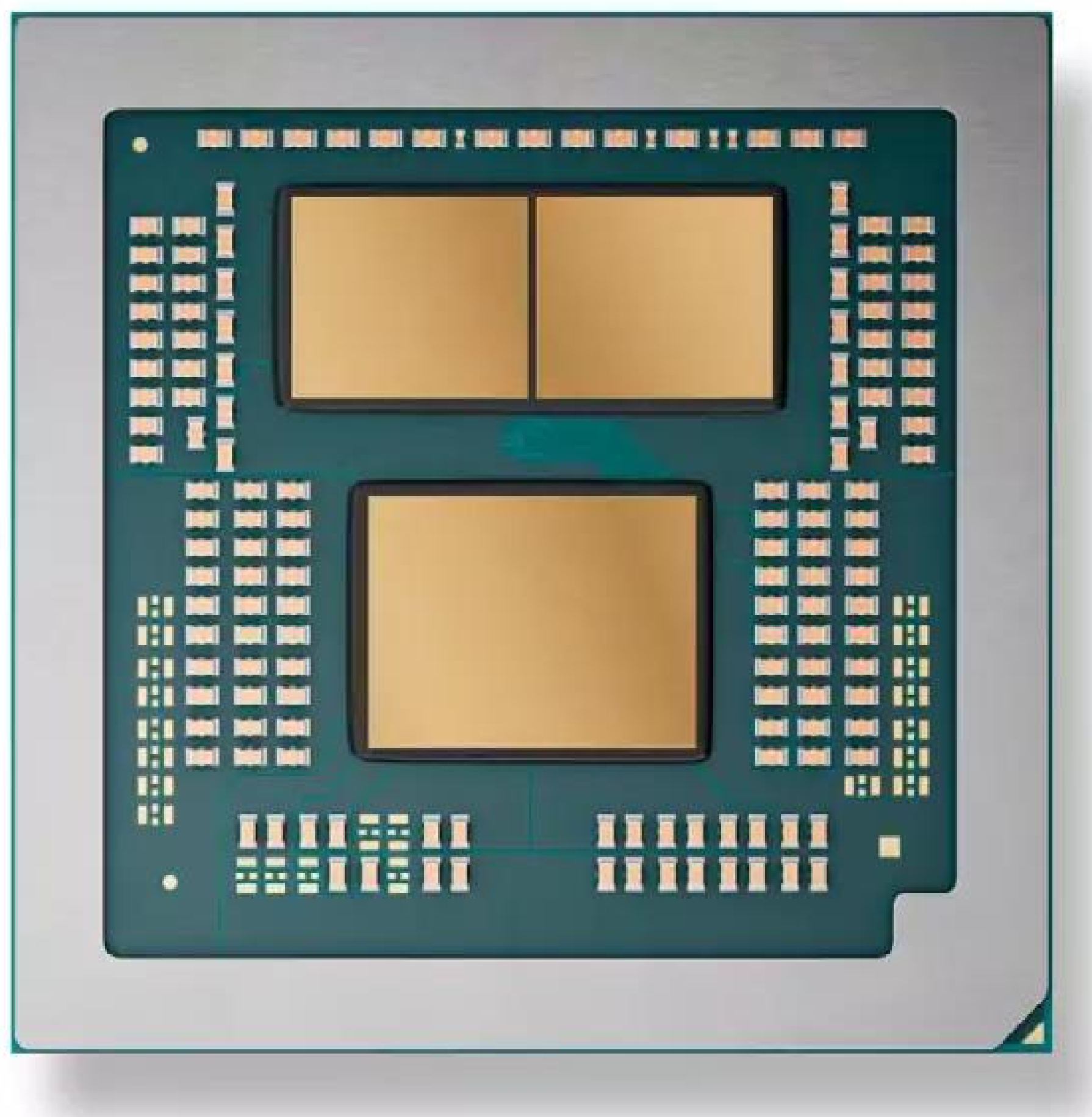
Okay, you can't buy this anywhere other than online resellers for ridiculous prices right now, but it was the biggest announcement for PC builders at this year's CES. Not only does it feature 21,760 CUDA cores, 32 GB of GDDR7 memory, and 680 5th-gen Tensor cores, but it manages to be remarkably slim and svelte, even fitting in small form-factor PCs. Read our review on page 74.

• Out: Now • www.nvidia.com • Price: $2,000

AMD RYZEN 9 9955HX3D

AMD's processors dominated the laptop space at CES this year, with Razer even using Team Red exclusively in its new Blade 16. This new high-end laptop chip is essentially a Ryzen 9950X3D with a 54 W TDP, so about as beefy as mobile CPUs come. 16-cores, 32-threads, 144MB of L3 cache, and a 5.4GHz boost clock is a staggering amount of silicon for a mobile device, even though it'll probably be limited to the 18-inch laptop category.

• Out: TBC • www.amd.com
• Price: N/A



ASUS ROG STRIX SCAR 18

When I buy a new gaming laptop, I try to open it and fill it with as much RAM and storage as it can take. Sadly, more and more manufacturers are choosing to solder everything in, especially on thin and light models. Asus is taking the opposite approach—simply slide a latch on the back panel, and you'll reveal diagonally mounted latch-held SSD drives and SO-DIMMs, which can be replaced, no tools required.

• Out: March 31 • www.asus.com
• Price: From $3,300

LENOVO LEGION GO S

The headline feature of this new handheld gaming PC is that it's the first device other than the Steam Deck to use SteamOS—a development that's been a long time coming. That's exciting enough, but the handheld itself also has all the right elements in all the right proportions, marrying an eight-inch 1,200p display with a choice of Z1 Extreme or Z2 Go APUs in a form factor that feels both familiar and comfortable.

• Out: May • www.lenovo.com
• Price: From $500

ALIENWARE AREA-51

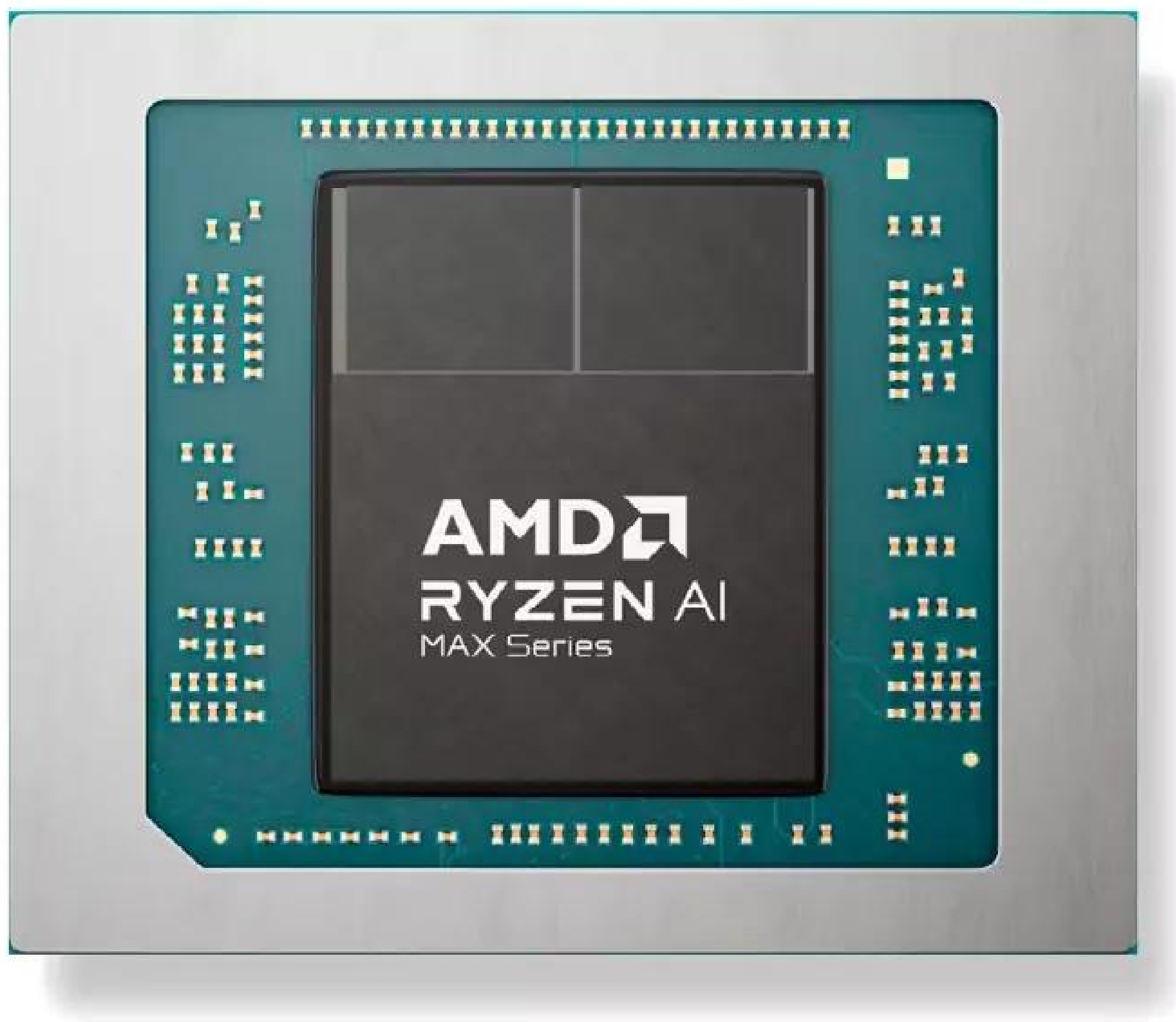
Alienware makes some desirable (if pricey) gaming PCs, but its tendency to use proprietary parts has traditionally been a sticking point. No longer with the new Alienware Area-51, as it now uses standard ATX motherboards and power supplies. The company has also festooned the insides with QR codes that link to tutorial videos on exactly how to remove and upgrade components. It's a genuinely good idea, and one that shows Alienware has been taking some of that upgradability critique on board.

• Out: Q1 2025 • www.alienware.com • Price: From $4,499

AMD RYZEN AI MAX

The long-rumored Strix Halo chips were finally in the flesh at CES. At the top of the range sits the Ryzen AI Max+ 395, a 16-core 32-thread 5.1 GHz beastie with 80 MB total cache. It's the iGPUs on these chips that excites, though, with the top chip getting 40 CUs, which could mean thin, light, dedicated GPU-less devices that can play games. The Asus ROG Flow Z13 looks like a candidate, although as usual, we'll need to run benchmarks ourselves. Still, exciting, isn't it?

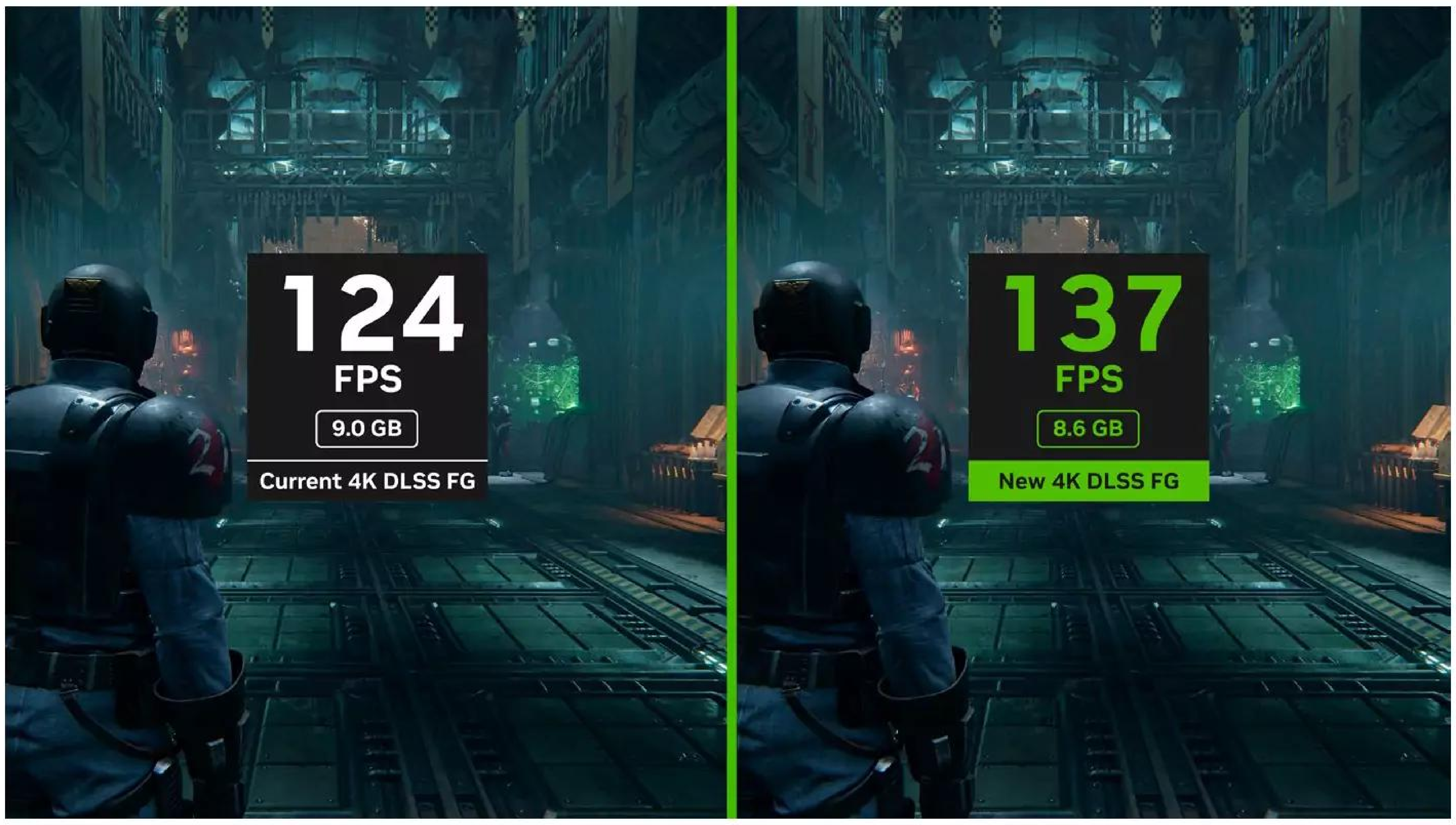
Out: Q1 2025 • www.amd.com • Price: N/A



RAZER PROJECT ARIELLE

We've seen gaming chairs with fans in them before, but Razer has taken things to the next level. Project Arielle can deliver a stream of cool air or even a blast of heat. I was expecting it to be a bit gimmicky, but having tested it myself, it was delightful. I reckon it won't be long before we see something like this available for sale.

• Out: N/A (Concept Product) • www.razer.com • Price: N/A



NVIDIA DLSS 4 MULTI FRAME GENERATION

The headline feature of Nvidia's 50-series cards, and probably the best implementation of AI we saw at the show, was DLSS 4. RTX users will be able to take advantage of its new transformer-based AI models that reduce ghosting, improve temporal stability, and provide higher detail. For the 50-series users, you get Multi Frame Generation, which can multiply frame rates by up to 8x over traditional brute-force rendering. 'Fake frame' doubters may protest, but we saw DLSS 4 in action, and it looked impressive.

• Out: Now • www.nvidia.com • Price: Free

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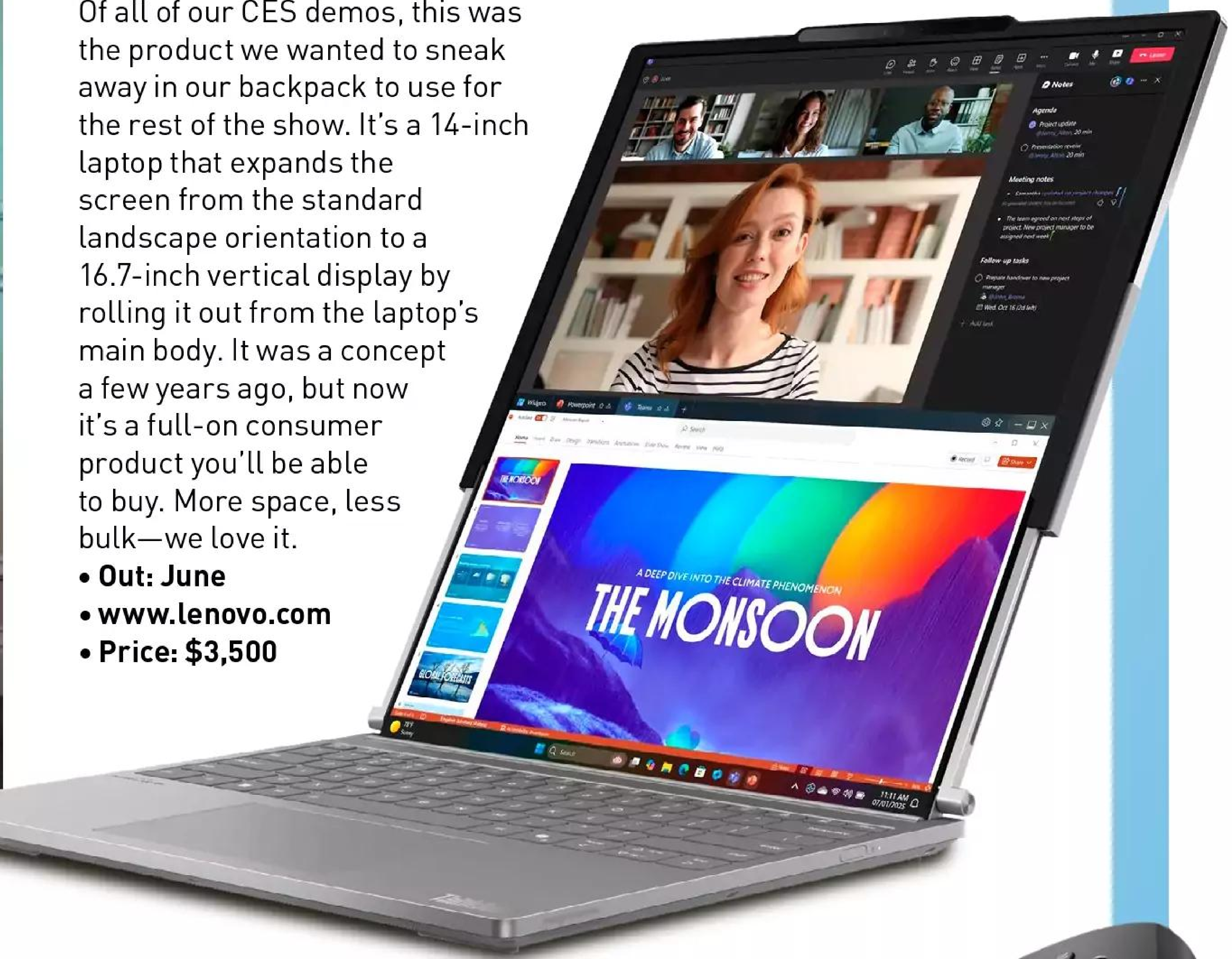


LENOVO THINKBOOK PLUS GEN 6 ROLLABLE

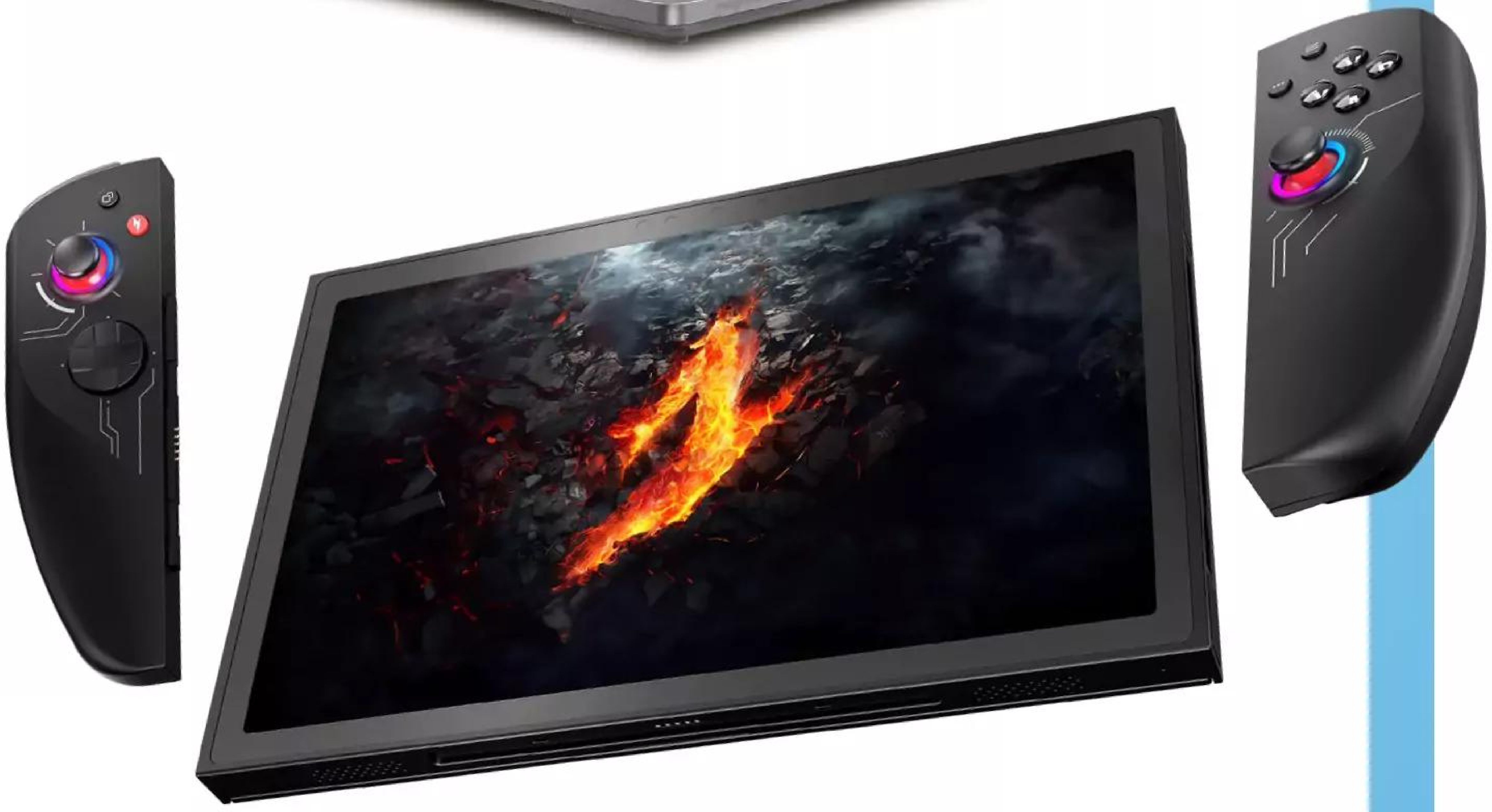
Of all of our CES demos, this was the product we wanted to sneak away in our backpack to use for the rest of the show. It's a 14-inch laptop that expands the screen from the standard landscape orientation to a 16.7-inch vertical display by rolling it out from the laptop's main body. It was a concept a few years ago, but now it's a full-on consumer product you'll be able to buy. More space, less bulk—we love it.

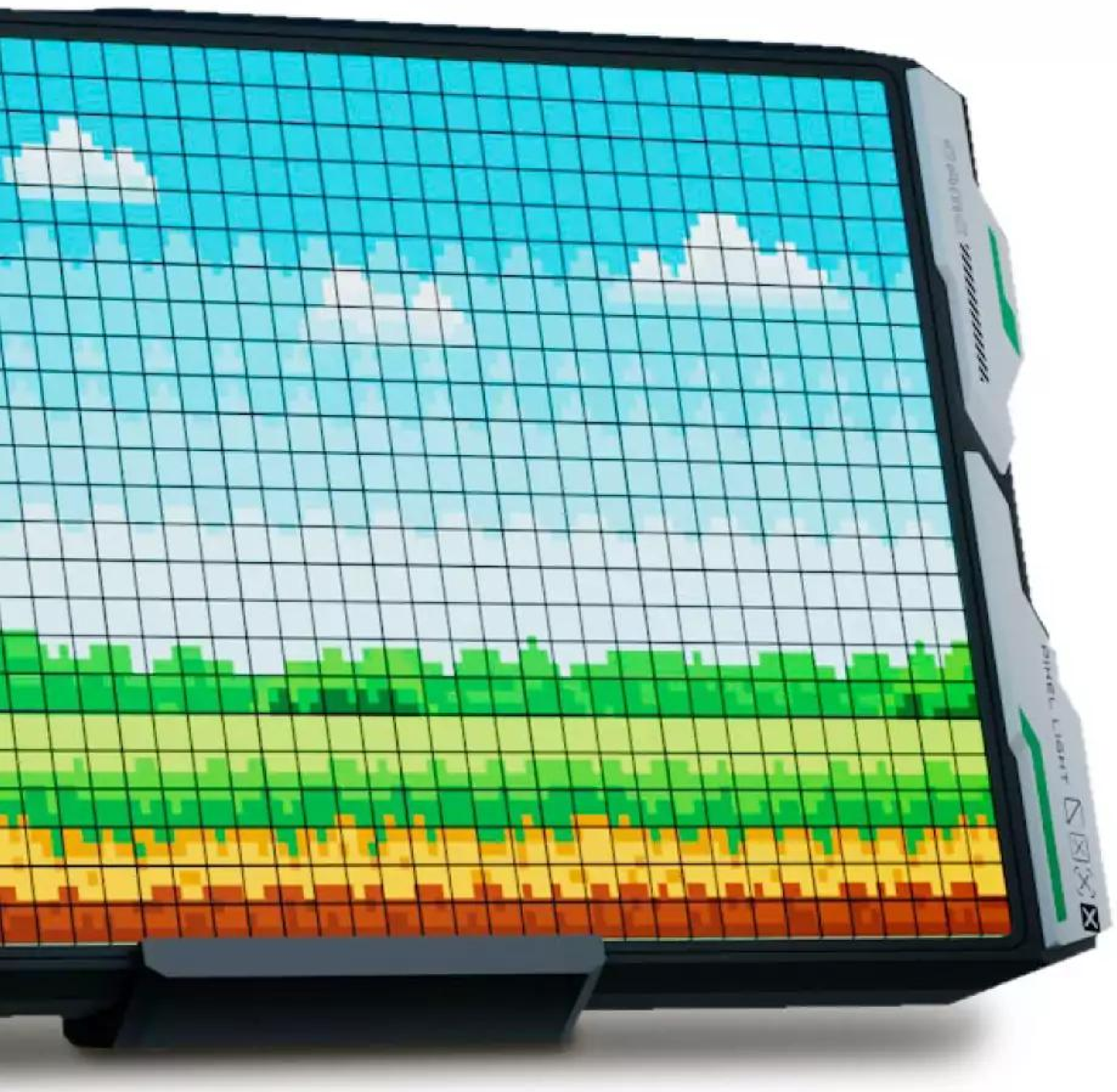
- **Out: June**
- **www.lenovo.com**
- **Price: $3,500**

ACER NITRO BLAZE 11

Our colleagues at TechRadar said that the 11-inch display is just too big for a handheld gaming PC, and frankly, we agree. But this being *Maximum PC*, there's also something we love about how excessive this (just about) portable games machine is. First of all, the price is as much as you'd pay for a gaming laptop, then there's the paltry 55Whr battery (presumably to cut down on weight) to worry about. But it offers a truly immersive portable gaming experience, and the detachable controllers are awesome.

• Out: Q2 2025 • www.acer.com • Price: $1,100





GOVEE GAMING PIXEL LIGHT

This small display synchronizes with Govee's DreamView technology to enhance your gaming setup. Simply plug it in, connect, and play one of the 40 compatible games to witness contextual light displays on this secondary display. Using Govee's app, you can also instruct an AI chatbot to create any images you can imagine, layering up to 10 generated images on top of each other. Govee's aim was to bring together a bunch of cool ideas into a product that will make you smile. It's succeeded.

• Out: 2025 • www.govee.com
• Price: $100

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PHISON E28 CONTROLLER

Phison was first to market with widely available PCIe 5.0 consumer SSDs. They remain the fastest drives around, but they have one critical drawback: they draw a lot of power, and can run quite hot, basically requiring active cooling. Phison will address this shortcoming with its second generation PCIe 5.0 controller, which is fabricated using TSMC's N6 process node. It will max out the interface with sequential read and write speeds of 14.5GB/s, and retail SSDs using it should launch this year.

• Out: TBC 2025 • www.phison.com

• Price: N/A

HP OMEN 32X SMART GAMING MONITOR

Lots of companies were bumping up their refresh rates, contrast ratios, or other specs at CES 2025, but HP has gone in a different direction to deliver a monitor that doubles up as a smart TV. That's thanks to Google TV integration, meaning all your favorite streaming apps are ready to go after a heavy gaming or work session. We'd have loved it even more if it was an OLED, but at 31.5-inches, 4K, and 144 Hz, it should satisfy most bedroom gamers. **• Out: TBC • www.hp.com • Price: From $749**

CORSAIR XENEON EDGE

Corsair's new monitor is a 14.5-inch, 2,560 x 720 touchscreen display that's made to show widgets like a calendar, the weather, or a list of shortcuts to open your favorite apps. The monitor connects via HDMI or USB-C alternate mode and has a series of magnets that allow it to stick to an included stand or even the outside of your case, including Corsair's latest models. You can also use iCUE to have it show your computer's CPU usage, temperature, and other key stats.

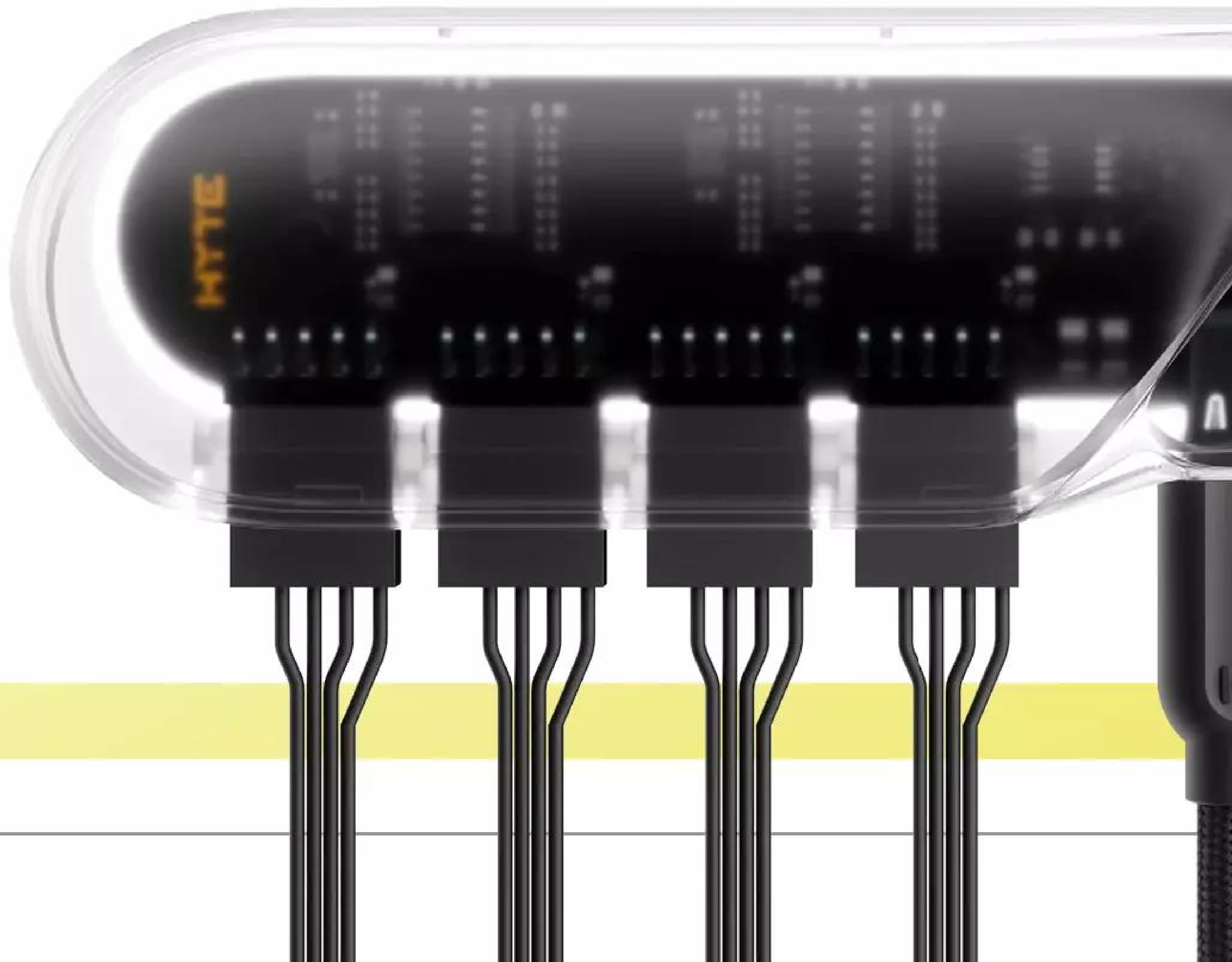
• Out: Q2 2025 • www.corsair.com • Price: $250

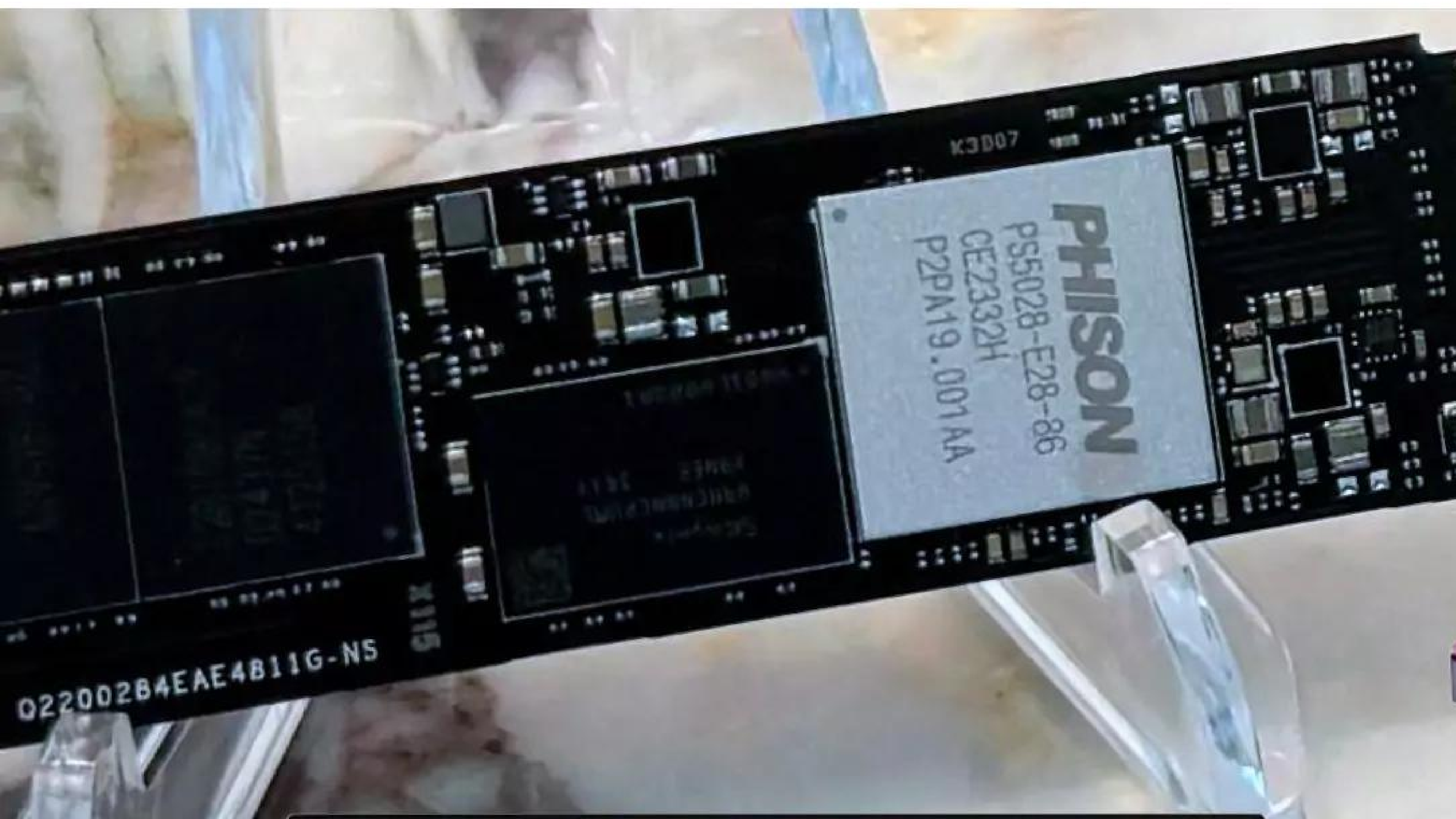
NVIDIA PROJECT DIGITS

Nvidia bills its new Digit as a personal AI supercomputer, delivering up to 1 petaflop of AI computing (FP4) from its new GB10 Blackwell GPU in a NUC PC-sized package. The system comes with a jointly developed Nvidia Arm processor designed in collaboration with MediaTek, and it could herald the first steps of companies, both of whom can sell systems based on the CPU, taking a broader step into both the desktop and laptop PC markets.

• Out: May • www.nvidia.com

• Price: $3,000





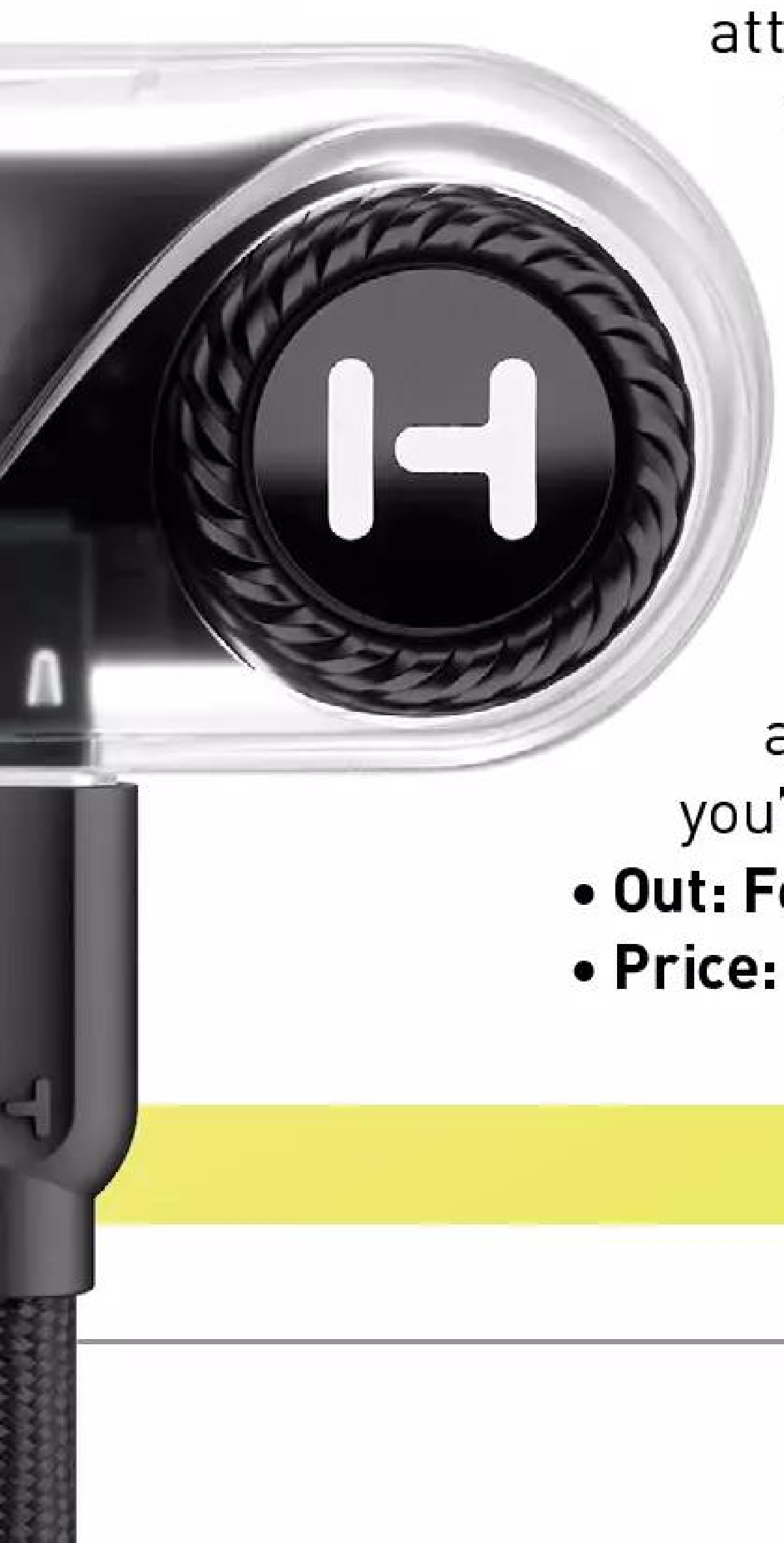
ASUS ROG SWIFT OLED PG27UCDM

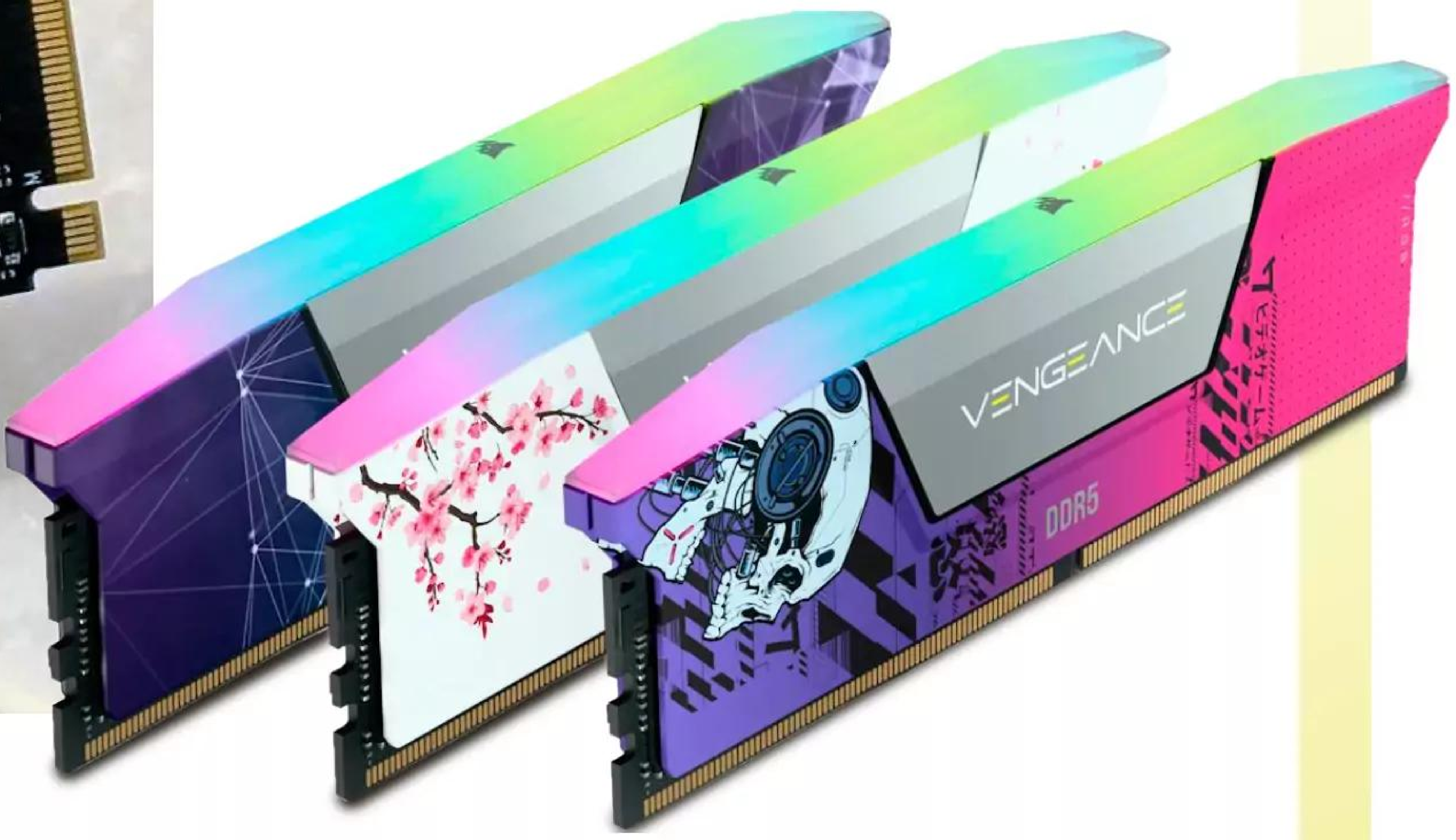
This monitor has it all: 4K resolution, OLED panel, and a 240 Hz refresh rate. There are a few such models around, but this one also boasts 99 percent coverage of the DCI-P3 color gamut, peak brightness of 1,000 nits and a response time of 0.03 ms. It also stood out thanks to its proximity sensor, which puts the screen to sleep when you walk away, saving your new investment from the risk of burn-in. • Out: Q1 2025 • www.asus.com • Price: $1,100

HYTE POWERED USB HUB

Hyte's USB hub is the luxury solution to your USB header woes, turning one header into four, while encasing the PCB in an attractive translucent package with a magnetic back for easy placement. All the ports are on one side, making cable routing easier and cleaner, plus it has a built-in light that helps illuminate your internal wiring. It might be overkill for many internal USB needs, but it's not super expensive, and it may be the last internal hub you'll ever need.

• Out: February • www.hyte.com
• Price: From $28

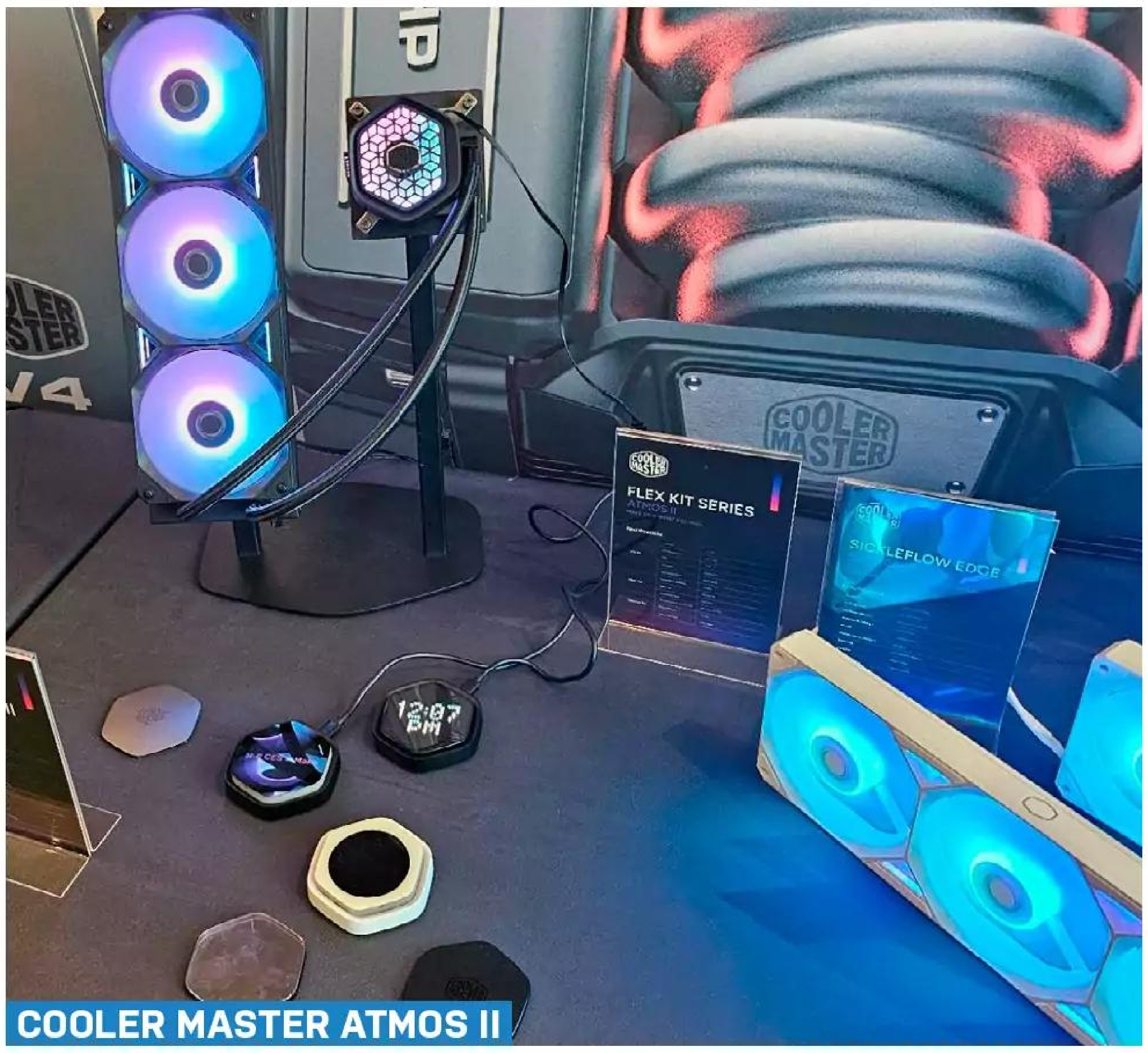




CORSAIR DDR5 CUSTOM LAB

Corsair has offered its Custom Lab site for a couple years now, but the company is now expanding the service to its Vengeance memory. It will offer eight designs to start across its three heat spreader colors: black, white, and gray. Speeds at launch will range from 6,000-6,400MT/s, and CAS latencies are said to be between 30 and 36. The company expects to offer more designs soon. Frankly, it's just nice to see some aesthetically pleasing RAM that isn't dominated by familiar company logos.

• Out: Q1 2025 • www.corsair.com • Price: TBC



COOLER MASTER ATMOS II

Cooler Master's original Atmos AIO was great, and the follow-up offers more customization and functionality to the mix. The block above the CPU is slimmer, and the company will offer a few swappable tops that attach via magnets. You can choose from simple caps in different colors, a circular LCD screen, or a hexagonal pixel display. There's even a cover that incorporates a small fan for VRM cooling. It will also offer the cooler with multiple radiator sizes.

Out: TBC • www.coolermaster.com • Price: TBC

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THERMALTAKE TS120 / 140

Thermaltake's new fan series has built-in temperature sensors to analyze conditions wherever you place them. They're not the first to do this (hello, Corsair), but these are much cheaper. Using the company's upcoming TT Plus RGB 3.0 software, these fans will be able to adjust their speed accordingly, plus you'll be able to see exactly how warm that area of your PC is. They'll also have attractive ARGB lighting on both the fan rings and sides.

- Out: Q1 2025 • www.thermaltake.com
- Price: $89 (TS120) or $94 (TS140) per pack of three

HYPERKIN COMPETITOR

Hyperskin is known for bringing the Duke Xbox controller (the massive one that launched with the original console) back for this generation of players. Its new controller is even bolder—it's for Xbox and PC players who might prefer the shape and layout of Sony's DualSense over Microsoft's efforts. That perhaps undersells the Competitor, because if you want a gamepad with symmetrical thumbsticks (with anti-drift measures) and back paddles, there's little else on the market. Let's hope there are no lawsuits, though.

• Out: TBC • www.hyperkin.com • Price: TBC

ASUS ROG FLOW Z13

The ROG Flow Z13 aims to prove that you don't need a dedicated GPU to game on the go. It comes packed with an AMD Ryzen AI Max+ 395 chiplet processor, with Radeon 8060S integrated graphics featuring 40 RDNA 3.5 graphics cores. The 2.5K resolution Nebula touchscreen display runs at 180Hz with 500 nits of brightness, and the whole thing comes in at just 12mm thick. If you do want to pair it up with a GPU, then you can with the ROG XG Mobile external graphic dock.

• Out: February • ww.asus.com • Price: TBC

XREAL One Pro

XREAL ONE PRO

Xreal's previous AR glasses have been caught in a loop trying to figure out how to hide those giant prism lenses and get spatial computing in a pair of specs. This new model is a significant step up, thanks to a flatter, smaller prism behind the lenses that means they're way more inconspicuous, while still offering the widest field of view. You can also attach a separate camera module to the nose bridge for 12MP pictures and videos, with gesture control coming later this year.

• Out March • www.xreal.com • Price: $600

COOLER MASTER MASTERFRAME 400 / 600

This is a sturdy case featuring easily swappable panels, allowing you to give your desktop a quick makeover. Based around an aluminum frame, the company plans to offer familiar tempered glass, mesh, and aluminum panels, and the company has showcased wood, frosted glass, textured acrylic, and stone panels as well. No word on how much these panels will cost, but the frame should be around $200 in each size. Even in its basic vented aluminum panel form, the MasterFrame looks great.

• Out Q1 2025 • www.coolermaster.com • Price: $200

MASTER FRAME
MASTER FRAME

G UltraGear™ OLED
LG

LG ULTRAGEAR OLED GAMING MONITOR 45GX950A

This LG offers 45 inches of OLED goodness, plus the ability to run in either 5,120 x 2,160 at 165Hz, or a lower 2,560 x 1,080 resolution at 330Hz. It may not be the first dual-resolution display, but it's certainly the prettiest we've seen so far. LG also showed off a flexible version of this screen, but we chose this version simply because we think it will appeal to more people and sell more units.

• Out: Q1 2025 • www.lg.com
• Price: $2,000

GEFORCE RTX

ASUS ROG ASTRAL RTX 5090 32GB OC

Yes, we know we already have an RTX 5090 on this list in the form of the Founders Edition, but we still have questions over the longevity of its liquid metal cooler and dual-slot design. The Asus ROG Astral is a much safer bet, thanks to its more traditional triple-slot design and four fans—three on the front and one on the rear. Coupled with a factory overclock, it should deliver some of the best out-of-the box performance we'll see from this generation.

• Out: Now • www.asus.com
• Price: From $2,800

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Snapdragon
X

QUALCOMM SNAPDRAGON X

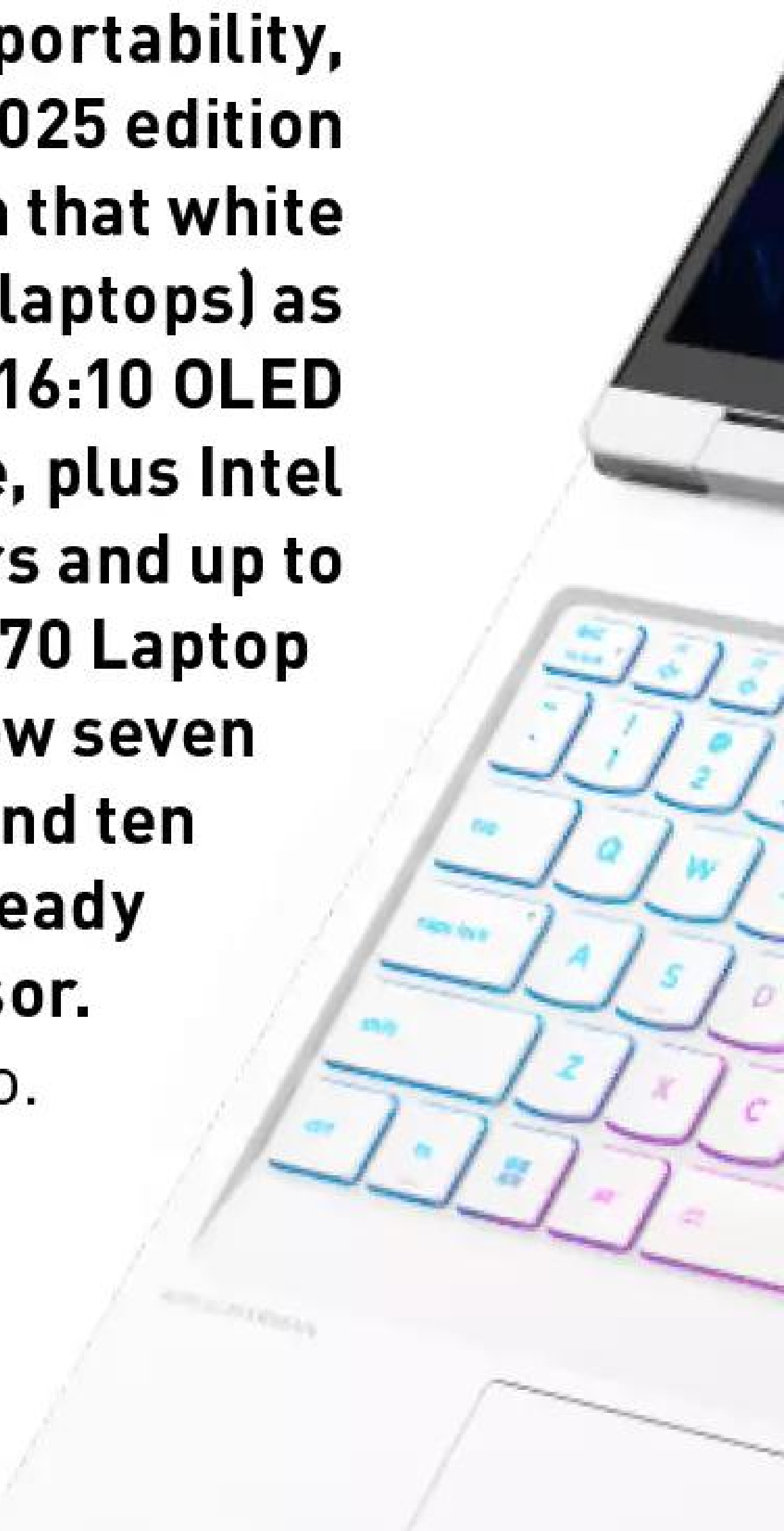
Following the highly successful launch of its ARM-based Snapdragon laptop processors, Qualcomm continues to work its way down the product stack. The Snapdragon X is a slimmed-down version of the 8-core X Plus chip, destined to sit in laptops in the $600 range. However, it'll still pack a punch, with a maximum 3.0GHz clock speed for the CPU and a GPU running at 1.7 TFLOPS, while the same neural processing unit remains at 45 TOPS, enough to qualify for Copilot+ status.

• Out: Q1 2025 • www.qualcomm.com
• Price: $600 (laptops)

LENOVO LEGION 7I

We're big fans of Lenovo's gaming laptops here at *Maximum PC*, particularly the 7i series, which combines great looks, portability, and performance. The 2025 edition will still be available in that white color (still rare for gaming laptops) as well as packing a 16-inch 16:10 OLED display for the first time, plus Intel Core Ultra 9 HX processors and up to an NVIDIA GeForce RTX 5070 Laptop GPU. Notably, it's also now seven percent lighter and ten percent thinner than its already svelte predecessor.

• Out: June • www.lenovo.com • Price: $1,600



HP OMNISTUDIO X

Our favorite all-in-one of the show was HP's first to be certified as a Copilot+ PC. It uses Intel's Core Ultra 200V processors with an NPU of 47 TOPS, which powers features like Windows Recall, advanced Windows Studio Effects, and Click To Do. There will be 27-inch and 32-inch models with 4K or 1080p displays, with an anti-glare coating and support for HDR 600, plus an HDMI-in port for connecting other devices—almost unheard of on an all-in-one PC.

• Out: Q1 2025 • www.hp.com • Price: From $1,100

SASUS ZENBOOK A14

A 2.18lb laptop powered by Qualcomm's Snapdragon X (or X Plus) that starts at just $899? Yes please! That weight is achieved thanks to the 'Ceraluminum' coating across its entire chassis. The 70WHr battery should supply "up to 32 hours of offline video playback", which we'd normally be skeptical of if it weren't for that Snapdragon chip powering it. The Snapdragon X version is on sale now, while the Snapdragon X Plus version is out in March.

• Out: Now (Snapdragon X), March (Snapdragon X Plus)
• ww.asus.com
• Price: $1,100 (Snapgragon X), $900 (Snapdragon X Plus)

ASUS Zenbook
ASUS Zenbook

ACER ASPIRE VERO 16

Acer's newest sustainable laptop is interesting. It promises to remain carbon neutral throughout its lifecycle, and Acer uses high-quality carbon credits to offset any outstanding carbon emissions. It also uses oyster shells (seriously) in its chassis, while the touchpad is made from plastic pulled from the ocean. Despite its eco-credentials, it'll still come packing Intel's new Core Ultra H-Series 2 processors and up to 32GB of LPDDR5x RAM. Even better, it starts at just $800.

• Out: April • www.acer.com
• Price: $800

SHURE MV7I

We love this new mic because it has a built-in audio interface in the unit, meaning you don't need a separate streaming mixer to get your podcast up and running. It comes packing the audio quality of the highly recommended Shure MV7+, SmartGate fixes your gain automatically, and the mic comes decked out with a Real-Time Denoiser and Digital Popper Stopper. You can even plug an XLR mic in for your podcast guest.

- **Out: Now**
- **www.shure.com**
- **Price: From $350**

INTEL CORE ULTRA 200H SERIES

Intel's Core Ultra 200V series was incredibly well-received at the end of last year, and the new H update builds on that success for people who just need something a bit more powerful. The new chips use the Arrow Lake architecture from the Core Ultra 200S desktop processors, which seem far more suited to mobile computing thanks to their power efficiency. The chips also offer integrated Intel Arc graphics, meaning gaming on thin and light laptops could also be on the cards. • Out: February • ww.intel.com • Price: N/A

MAINGEAR APEX FORCE

Maingear is one of the best pre-built desktop manufacturers out there, and its newest creation is one of the best-looking pre-built PCs I've ever seen. It uses a Phanteks NV9 case, dual 420mm radiators, and dual custom cooling loops. You can customize everything from the cabling to tubing materials, color, fittings, sleeves, and more. It will include Nvidia's new RTX 5000 GPUs, the latest chips from AMD and Intel, and up to 96GB of DDR5 RAM. There's no price yet, but there is a fully refundable $100 deposit for those who want one.

• Out: Q1 2025 • www.maingear.com • Price: $TBC

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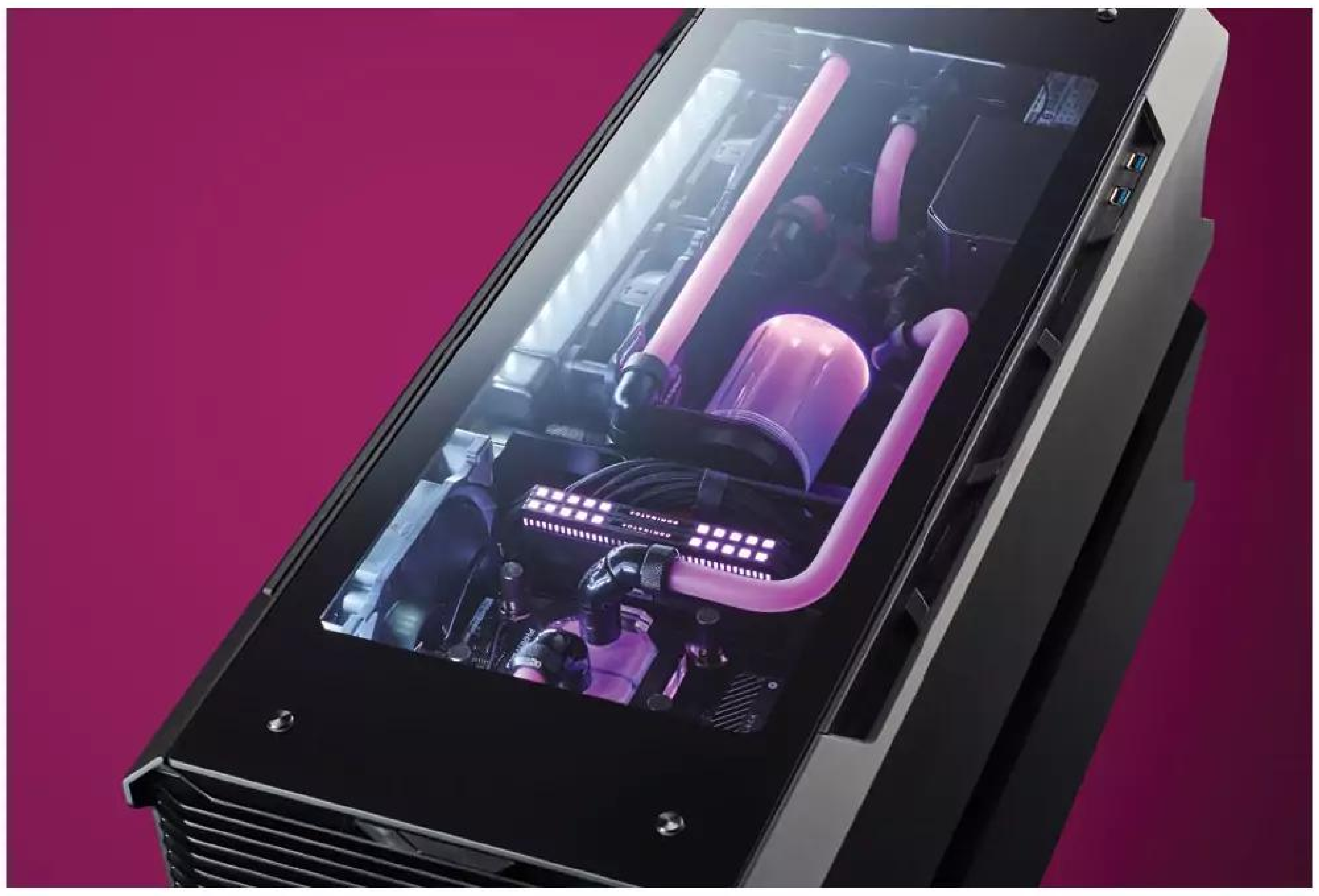
BLUEPRINTS UNWRAPPED

Zak Storey tells you what you need to know when planning your next build

BUILDING SYSTEMS is what we do here at *Maximum PC*. It's the bread and butter of what makes this publication what it is. Over the years, we've built a whole host of systems, targeting every concept, budget, and product you can imagine—all in an attempt to keep things fresh, topical, and up to date.

With that comes knowledge—buckets of the stuff. It almost becomes intuitive, knowing what components will fit where, how much a chassis can take, how best to take advantage of cooling in a case, which hardware to pick to make life easy, and what components represent the best bang for the buck. But it's perhaps something that we've often taken for granted.

In our February issue, we had a great community question on page 95. Blake Wells suggested we take a step back from the long-form build features and blueprints, and explain just how we go about picking the parts we do. How do you avoid compatibility issues? Will your CPU be fast enough not to bottleneck your GPU? And how do you future-proof your rig, ensuring it's trouble-free and simple to build, too? These are all fantastic questions, and ones that we're going to dive into right now.



ANSWERING THE PIVOTAL QUESTIONS

It might be dull, but this is without a doubt the most important part of any build process, even the ones we piece together here

ALL GOOD BUILDS START WITH good research. For us in particular, it's pivotal that we create systems that not only represent good value, but are logical as well. They have to meet a certain budget, and often be aligned correctly with one another, avoiding bottlenecks, cooling disasters, power delivery issues, and other maladies (no point pairing a Core i3, with an RTX 5090, with a 450W PSU in a case with no airflow, after all). There are occasions where we deviate from that, of course, usually to try out a random piece of hardware, to answer a question or satisfy a curiosity, but that's almost always at the forefront of our mind when building out a parts list.

All that aside, regardless of whether you're tech media or not, it's research that's the saving grace of any good system build. Answer some basic questions about what you're trying to achieve, and then heavily research the components that you have in mind.

To get started, there are a few key elements we need to pin down; categories of questions that need answering. You can hyper-fixate on the detail here, or just have a rough idea, but these are generally the best places to start.

All good builds start with a few good questions.

1: WHAT'S YOUR BUDGET?

This is vitally important, perhaps more so than anything else, as it'll determine how to best allocate the finances you have. For instance, a $1,500 budget is far more 'valuable' than a $3,000 one. That might sound counterintuitive, but the less you have to spend, the more precise you need to be with your allocation.

If you pin money on a Ryzen 5 when you could have gotten a Ryzen 7, and saved a bit of cash on a lower-spec GPU instead (opting for a reference card instead of an overclocked Hyper Super Nova Deluxe OC X card), you'll be leaving performance on the table for more computationally heavy tasks.

Similarly, there's no point spending $400 on a graphics card if your $100 CPU becomes the bottleneck. So understanding what the budget is, whether it can stretch, and what you can do to mitigate cost, is a big one. Think about what components you can bring over to the new system, and if you need to buy it all in one go. Do you care about aesthetics? Can you get away with a cheaper motherboard? All of this can dramatically reduce costs and improve performance in the process.

2: WHAT DO YOU WANT IT TO DO?

You also need to establish exactly what it is you're doing with your build. Are you a gamer? Are you looking to render on it? Trying to build a machine that can browse the internet smoothly and dabble in office work and desktop applications? Do you need it to be super-reliable, on for days and days at a time? What's your environment like? HVAC home office, or dust-filled workspace? Are there size requirements? Does it need to be a small, portable thing instead?

Again, the answers here will dramatically dictate how you should assign that cash; which case you should buy, what cooling you should use, and so forth. They're not hard and fast rules, and PCs are massively versatile, of course, but they should at least influence your part-picking decisions.

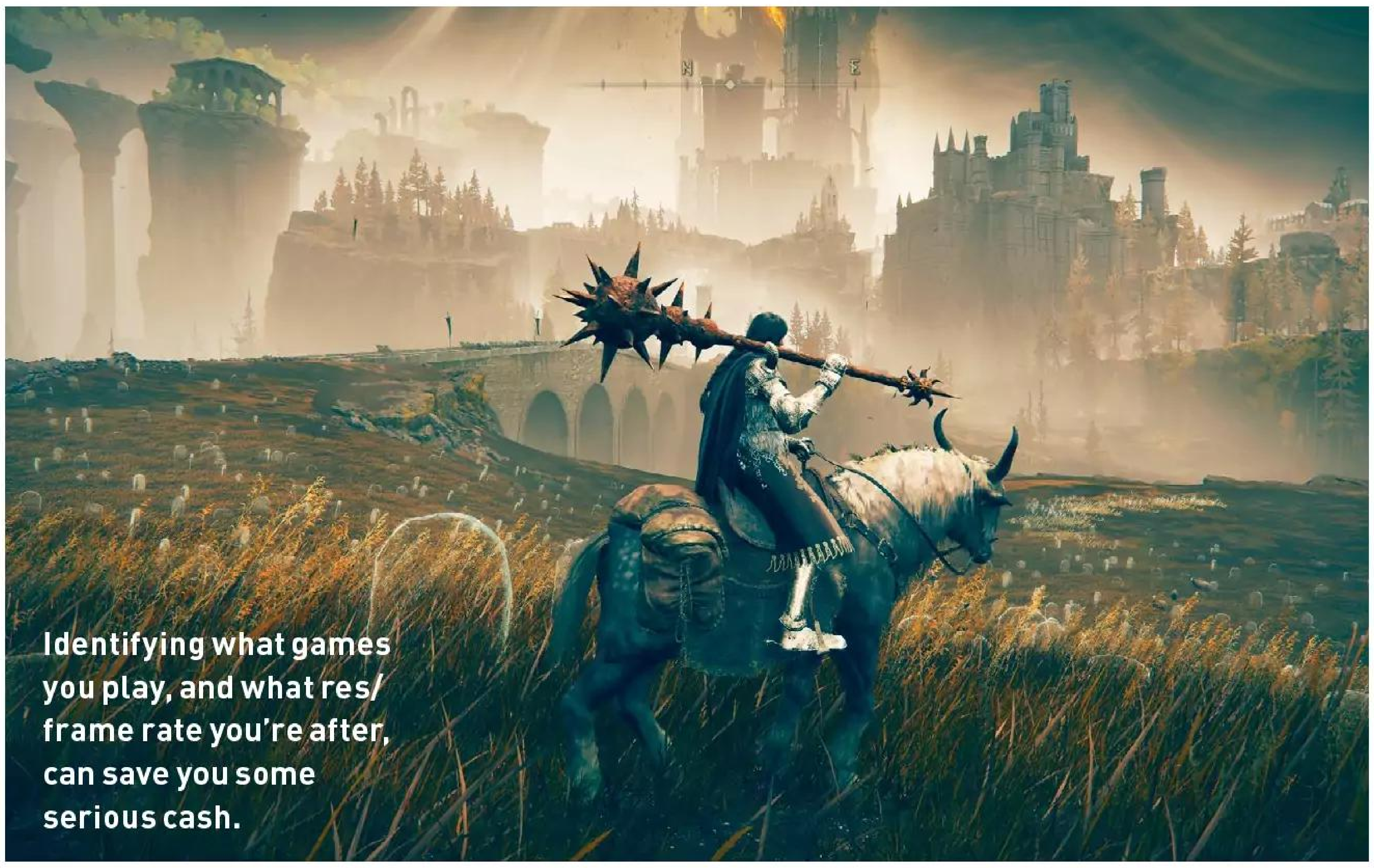
If you're only interested in gaming, then leaning more into a graphics card will have a bigger impact than pumping a ton of money into RAM and SSDs. Similarly, if video rendering is the name of the game, then CPU threads, large-capacity RAM, and storage will be a far better investment than fancy RGB componentry.

3: HOW EXPERIENCED ARE YOU AT BUILDING PCS?

It's perhaps a more tertiary question, but relevant nonetheless, particularly if you're building the PC yourself. How confident are you? Entry level? Never built a PC before? Alternatively, how patient are you? After all, all PC builders start somewhere; if you've got the time and patience, you can master any system, from the most complex, ITX liquid-cooled build to the most extravagant full-towered air-cooled twin PSU monster. Do you relish the challenge, or are you just after a simple, straightforward build?

CASE STUDY: BUDGET ALLOCATION

BEFORE WE GET ON to the actual process of picking parts, we need to decide how to allocate that money. We've got a few sample studies below that should hopefully help answer some of those questions.



Identifying what games you play, and what res/frame rate you're after, can save you some serious cash.

© BANDAI NAMCO ENTERTAINMENT

GAMING

In short, if you're building a rig in 2025, and are solely interested in gaming, you need to start with a discussion on what your target resolution is going to be, what games you're interested in playing, and what frame rate you want to hit. You then need to be reasonable with your expectations. A budget of $1,000 isn't going to net you 4K 120fps in *Cyberpunk* without some serious DLSS backup, and even then, that's going to be a push.

Bottlenecks are the primary concern we're trying to bear in mind here. As an example, if you're into playing esports titles at 1080p, but require 200 fps+ and beyond to compete, then you're going to need a CPU with incredibly potent single-core performance, alongside a powerful graphics card. A strong CPU will ensure you don't hit a bottleneck where your processor speed is limiting how many frames the graphics card can render at any one time.

If you're moving up the resolution scale, and are focused predominantly on the 60-144 fps mark, then allocating more currency to your graphics card instead of your CPU can be more beneficial. A Ryzen 5 or Core Ultra 5 will serve you well here, and still deliver ample performance when needed, without stymying your GPU's potency.

This applies doubly for 4K and high resolutions; as the resolution climbs higher, load is often shifted more on to the GPU instead of the CPU, and the likelihood of hitting frame rates above 60fps diminishes. In short, if your CPU can deliver 60fps at 1080p without bottleneck, it should be capable of delivering 60fps at 8K as well.

For memory, we highly recommend around 32GB at this point; any more is unnecessary. Although DDR5 doesn't actually improve gaming performance compared to DDR4 (we're way past the land of bottlenecks with current memory speeds and latencies), it's so cheap nowadays, and a mainstay of mainstream chips, you may as well grab it anyway and not limit yourself. 32GB of capacity will also ensure you've got plenty of spare memory to run other programs in the background. As for speed, as long as you're on the 6,000MHz mark for Ryzen's Infinity Fabric (Intel still doesn't matter), you'll be golden.

As for solid-state storage, the reality is that any good PCIe 4.0 drive will do. Heck, even an old-school 2.5-inch SATA SSD will still easily deliver. Gaming really struggles when it comes to benefiting from PCIe storage speeds, even today. Again, it's no longer a bottleneck for modern titles, even with eight-year-old hardware. You'll notice that when we review SSDs, we use *Final Fantasy XIV* benchmark load times as a measurement metric. In those tests, we compare drives to one another, labeling one good and one bad, despite the fact that they usually load within less than one second of each other. In the real world, that's just not perceiveable. If you're not doing large file transfers regularly or similar workloads, SSD performance really doesn't matter that much above PCIe 3.0 speeds.

As for budget allocation, at 1080p high frame rates, your GPU ought to be about 10 percent more expensive than your CPU. At 1440p mid-frame rates, your GPU ought to be about 20 to 30 percent more expensive than your CPU. For 4K, 50 percent and above is probably what we would recommend.

PROFESSIONAL/CREATIVE WORKLOADS

When it comes to more advanced builds—those situated around number-crunching floating point calculations, rendering, and more creative workloads—recommendations become increasingly difficult to generalize. A lot of it is going to depend on what programs you

HUNTING FOR RELIABILITY

If all you're interested in is reliability, then you need to specifically look for that. A good rule of thumb is to go with trusted brands with good, solid warranties or recovery services. Seagate, Noctua, Crucial, Seasonic, EVGA, Corsair, and Samsung are a few that come to mind.

Additionally, think about reducing moving components to a minimum. Anything that spins or has mechanical parts is likely to break. Get rid of anything that can add additional unnecessary heat, and find components that are well built and secure: M.2 drives instead of 2.5-inch drives; better and more robust cooled graphics cards; air towers instead of AIOs, and big 140mm fans instead of 120mm ones.

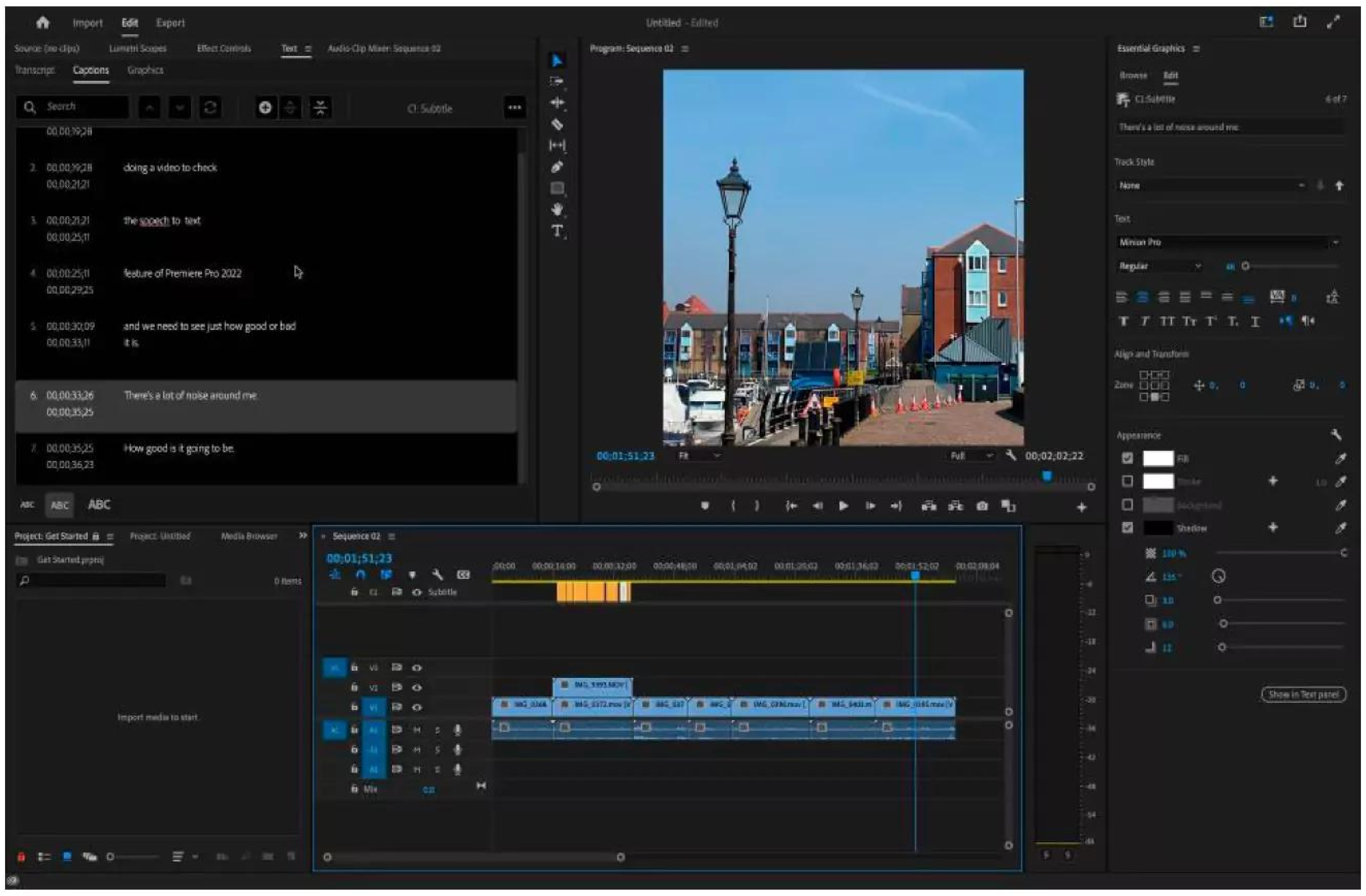
Then, consider what you can do with your system itself. Keep fan RPMs stable at a fixed percentage, ensure temperatures remain as low as possible during high utilization workloads, ensure auto-overclocking features are disabled by default, eliminate any unecessary lighting, and keep XMP or EXPO turned on for your memory. Only push driver updates a week or two after debut (if there are no issues), ensure you're not subscribed to any Windows Insider programs, and update your BIOS regularly with the latest patches.

use and how they access and allocate system resources.

For instance, take DaVinci Resolve and Adobe Premiere Pro. Both are fantastic video editing tools (although admittedly, Resolve is more about color grading), which is ideal if you're working on large 4K files. Resolve, however, is far better optimized in terms of accessing GPU resources, as it often prefers to use them for everything from direct rendering to color grading and more.

Premiere Pro, on the other hand, tends to lean more on multi-threaded CPUs with higher clock speeds, thanks to an aging and older legacy code base developed and built out during a time where CPU performance was more dominant in the rendering arena. If your business or industry—or even just personal preference—lies with one over the other, then it makes more sense to allocate your funds accordingly based on those facts. That's not to say Premiere doesn't utilize the GPU either—there are plugins for that, and it can take advantage of Nvidia's latest codecs—it's just that it's far less efficient than Resolve is at it. It's a very similar kind of ethos to Arm versus X86, in that regard.

One thing that is fairly consistent across these tasks, however, is file access speeds and latencies. That's where faster storage and RAM can become critical, particularly when working with larger resources and file sizes. As a minimum, we'd recommend 32GB of DDR5 for any application where you're earning money from it, along with some high-speed storage both for your OS and your primary work drive, where your machine accesses those resources to render. Although memory frequency will make a difference here, from our own experience, capacity still seems to be king when it comes to delivering an increase in performance—usually by a factor of 2–4—versus memory speed directly.



2. 00;00;19;28 00;00;21;21 doing a video to check
3. 00;00;21;21 00;00;25;11 the speech to text
4. 00;00;25;11 00;00;29;25 feature of Premiere Pro 2022
5. 00;00;30;09 00;00;33;11 and we need to see just how good or bad it is.
6. 00;00;33;26 00;00;35;25 There's a lot of noise around me.
7. 00;00;35;25 00;00;36;23 How good is it going to be.

Adobe's Premiere Pro is on aging code, and it just can't quite keep up with DaVinci Resolve on GPU resource access.

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Again, research is going to be your best friend. Identify your most mission-critical programs, use Google and YouTube, search those communities, find out whether the program in question prefers CPU or GPU performance, and ask how much RAM you need. Whether it prefers AMD or Nvidia graphics cards, Intel, or Ryzen processors, you'll quickly find out what's best for your machine.

COOLING CONSIDERATIONS

Of course, regardless of what build you want, we all like a bit of reliability in our systems. However, workloads between gaming rigs and professional systems tend to vary quite wildly. A crypto-mining rig, a render-farm, NAS, or any similar system will likely be online for multiple days at a time, typically working at 100 percent utilization for long periods.

A gaming system, on the other hand, may at most be running for eight to 16 hours a day, with pauses in load intensity during those periods. It's also highly unlikely that all your components will be running at maximum load constantly while gaming. Some scenes and situations won't stress your GPU or CPU as hard as others. With that in mind, temperatures and power draw will likely be lower, and that has an effect on the componentry that we choose both to cool and power the machines.

For professionals, reliability and durability is going to be key. Find a case with good airflow and plenty of support for fans, and then pick cooling solutions that similarly fit the bill. Noctua air towers are fantastic options for these kinds of builds, along with its fan line in general (the NF-F12s and A14s are legendary at this point). The CPU towers in particular these days are ridiculously easy to install and insanely reliable. If a fan breaks on a heatsink like that, you just need to replace the fan. However, if the pump breaks in an AIO, you have to replace the entire AIO, taking the system out for multiple days, potentially at a larger cost.

Additionally, if a fan fails on a heatsink tower, the tower will still work passively for a time, and your system won't immediately die. Yet, if an AIO fails, the pump doesn't move the coolant, and you'll see an overheat in less than a minute.

For gamers, because the workloads and stresses on your machine are so much lower, AIOs provide far superior cooling, and if we're honest, do look a lot better. As such, it almost becomes justifiable to go with a liquid-cooler instead, as although there is technically more risk with a pump failure, you're highly unlikely to see it occur, and if it does, it's not about to start costing you money outside of the investment on the part.

Noctua now has a legendary reputation for its cooler reliability and performance, and with good reason.

FUTURE PROOFING

There's always something better over the horizon

ONE OF THE most commonly asked questions we get is whether it's possible to future-proof a build anymore. The reality is that it's an incredibly hard question to answer for a number of reasons. Firstly, it does entirely depend on how you use your system and what you use it for.

There are many folk out there that are quite happy with ten-year-old machines, ticking along playing *World of Warships* or toying around in *League of Legends* for years to come. Perhaps you've just got a system that browses the internet, and that's all you need. In this case, yes, future-proofing is less of an issue.

Interestingly, it's something we see predominantly more with consoles than gaming PCs. Unlike the computing industry, major consoles tend to only launch once every five to seven years. On the other hand, in the land of the custom transistor, no graphics cards or processors have a 1-2 year life-span. In short, if you're on the hunt to own the best of the best, into perpetuity, the PC ecosystem will inevitably cost you far more than its console counterpart.

THINGS YOU CAN DO

Aside from being aware that buyer's guilt is almost an inevitability in this industry, with new, faster hardware launching every 6-12 months likely dramatically reducing the cost of the product you paid full price for, there are a few tips and tricks we can suggest to help offset and future-proof your system.

1: IDENTIFY YOUR CPU SOCKET LIFECYCLE

The big one at the moment has to be socket support and motherboard selection. AMD, for instance, has been legendary for this over the years. Even now, it's still supporting its AM4 platform with a new set of chips, giving the socket a lifespan of well over eight years.

It's not improbable to find a good solid motherboard you like and stick with it for that length of time. Intel refreshes its socket far more often, but for long-term lifespan, AMD truly is the king. AM5 is pegged for official support all the way up to 2027 at the very least.

The best play, then, if you're looking at building a system soon, is to hold out for AM6, grab a motherboard, and enjoy likely support all the way up to 2032.

AMD's committed to supporting AM5 up to 2027

2: BUY A BEEFY PSU

Weirdly, bigger power supplies are generally a safer bet than smaller ones. Although transistors should get more efficient the smaller they become, how manufacturers pivot their die size and chip designs can offset that quite dramatically. Having a beefy PSU that gives you plenty of headroom for when new products arrive with higher or lower demands gives you a lot more flexibility and allows you to use the same PSU across multiple generations, as long as all the cables and connections remain the same.

You may have to sacrifice efficiency here, but it's a minor price to pay, all things considered. Just remember to safely store any of those spare cables that you might need later down the line.

3: CASE COMPATIBILITY & COOLING

Without a doubt, you can save big here, too. Find yourself a large case with plenty of compatibility for long cards and solid cooling support, and you will once again be able to swap hardware in and out easily without having to worry about case compatibility or potential cooling hiccups if things get dusty.

4: MORE RAM, BIGGER STORAGE

Given how far ahead NAND and DDR technology is these days, you're certainly not likely to struggle on the speed front. It won't become a bottleneck—at least not for the next five to ten years. Computing, programming language, and resource management haven't particularly changed that dramatically on x86 systems for some time now, and unless we see a paradigm shift in how we process data or AI explodes into a program you can run locally, that's not likely to change.

What may change, however, is how much capacity we require. Ten years ago, 16GB of RAM was considered top-tier. Today, it's barely entry-level. With that in mind, opting for 64GB of DDR5, or even more than that, could give you enough headroom for many years to come. Similar to our socket conundrum mentioned above, AMD has committed to support DDR5, at least until 2027 and the AM5 platform reaches EOL.

PICKING THE RIGHT POWER SUPPLY

Choosing the right PSU for your build is quite a simple decision these days. We highly recommend using a calculator to find the right wattage for your build. But do bear in mind that most overestimate on purpose for your safety and protection. They also typically operate under the notion that all components will be drawing the maximum amount of energy from the wall at 100 percent load. In the real world, that's just not a feasible scenario, as one component will almost always bottleneck another, even if it's just by five to ten percent.

Take our feature build this month, complete with Core Ultra 9 285K and RTX 5090. According to PC Part Picker, they rate the estimated wattage at exactly 999W, yet during our entire benchmark run, it only topped out at 850.4W, around 150W shy of what PC Part Picker assumed it would draw. That's not to say higher power draws can't be achieved; just that these calculators often plan for the worst.

With that in mind, generally power supplies are most efficient at around the 80-percent load mark (this is why we have the 80+ Gold, Platinum, and Titanium ratings). Below and above that, you'll typically find that efficiency drops off, typically from excess heat, and that can impact your electricity bill or mean you've spent more on your PSU than you need to.

If PC Part Picker suggests your spec will hit 1000W, however, aim to go 20 percent higher on the spec, and pick up a 1200W unit. Aim to get a modular unit so you can remove cables to make your build easier, and always buy from a reputable brand with a ten-year warranty on the unit.

EASY BUILDS & COMPATIBILITY

We've identified what we need; now we need to figure out what it fits in

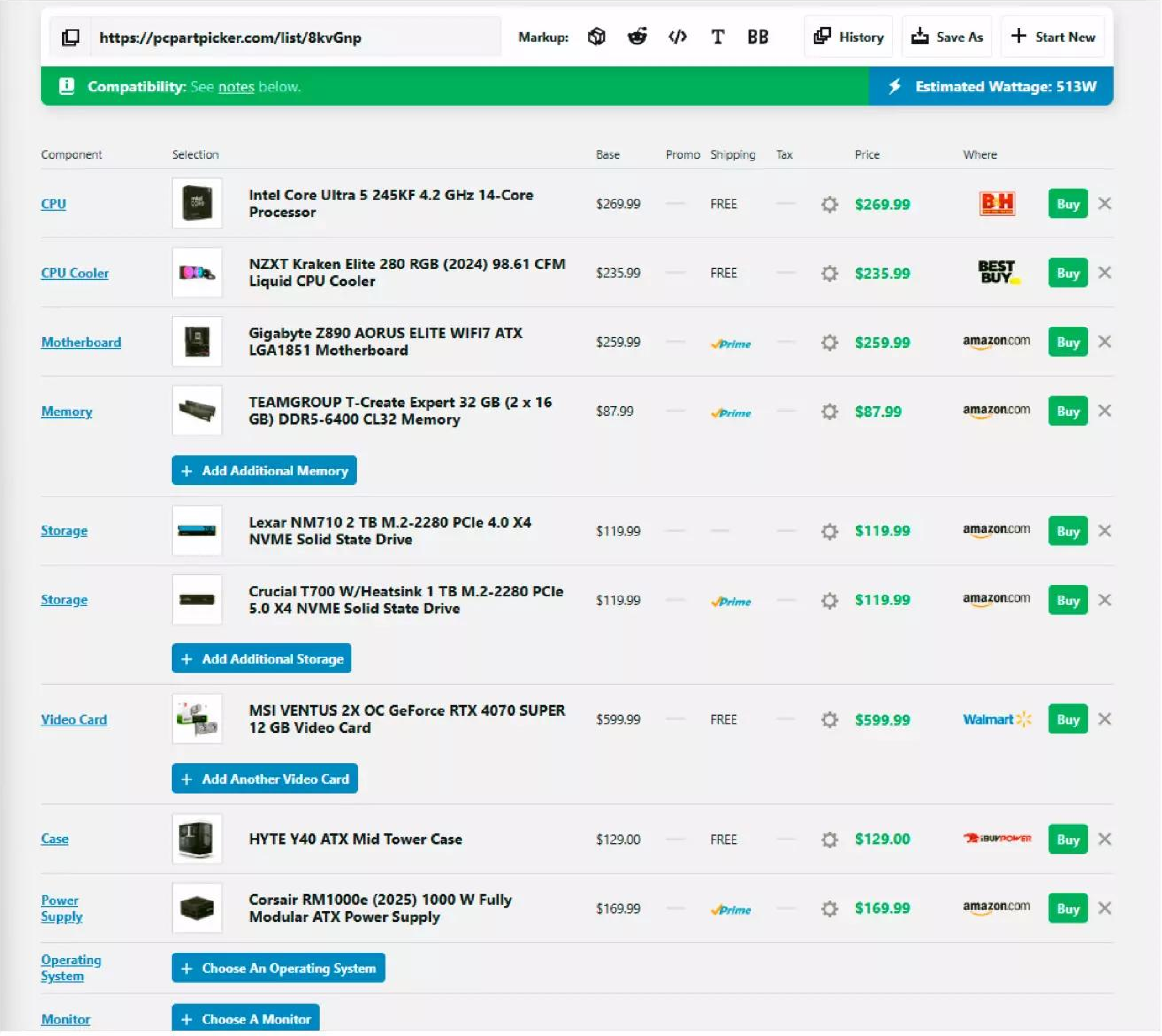
NOW THAT WE'VE identified our core parts and what we need, it's time to move on to deciding exactly what case we're going to use and how to check compatibility. It goes without saying that if you want the simplest build possible, get a big chassis; something on the bigger end of a mid-tower or ATX build will do you wonders. Stick with an ATX motherboard, stay with M.2 SSDs, and find yourself a good, simple cooler to install. Combine that with a modular power supply, and it's not too difficult to get a system up and running in even under an hour.

When we're reviewing cases in particular, we're always trying to identify features that will make a build easier to manage. In an ideal world, things like removable radiator brackets, power supply covers, and good cable management solutions in the back (this can be velcro straps, plastic routing channels, or cable tidy bars) make a huge difference. Find a chassis whose panels are toolless, and comes with an inbuilt fan controller or similar, and you're quickly on to a winner.

ProArt
Art
ProArt

Cable management solutions help simplify arguably the hardest part of any build.

It's why cases like NZXT's H7 line, Hyte's Y40, Corsair's 4000D, or Lian Li's PC 011 series get so much love. They're common cases, of course, but for good reason, as they feature a whole host of elements that make a PC build far easier to manage.



Component	Selection	Base	Promo	Shipping	Tax	Price	Where
CPU	Intel Core Ultra 5 245KF 4.2 GHz 14-Core Processor	$269.99	—	FREE	—	$269.99	BH
CPU Cooler	NZXT Kraken Elite 280 RGB (2024) 98.61 CFM Liquid CPU Cooler	$235.99	—	FREE	—	$235.99	BEST BUY
Motherboard	Gigabyte Z890 AORUS ELITE WIFI7 ATX LGA1851 Motherboard	$259.99	—	Prime	—	$259.99	amazon.com
Memory	TEAMGROUP T-Create Expert 32 GB (2 x 16 GB) DDR5-6400 CL32 Memory	$87.99	—	Prime	—	$87.99	amazon.com
Storage	Lexar NM710 2 TB M.2-2280 PCIe 4.0 X4 NVME Solid State Drive	$119.99	—	—	—	$119.99	amazon.com
Storage	Crucial T700 W/Heatsink 1 TB M.2-2280 PCIe 5.0 X4 NVME Solid State Drive	$119.99	—	Prime	—	$119.99	amazon.com
Video Card	MSI VENTUS 2X OC GeForce RTX 4070 SUPER 12 GB Video Card	$599.99	—	FREE	—	$599.99	Walmart
Case	HYTE Y40 ATX Mid Tower Case	$129.00	—	FREE	—	$129.00	iBUYPOWER
Power Supply	Corsair RM1000e (2025) 1000 W Fully Modular ATX Power Supply	$169.99	—	Prime	—	$169.99	amazon.com
Operating System	Choose An Operating System						
Monitor	Choose A Monitor						

A $2,000, 3,440x1,440 system spec.

© PC PART PICKER

RESEARCH, TECHNICAL SPECS, AND PC PART PICKER

A lot of that again is going to come down to research. Find a case that you like the look of, then find reviews of it. Comb over the content, identify common pitfalls and hardware install errors, then take steps to avoid them. Spec sheets and product pages are invaluable when it comes to checking compatibility.

The same goes for coolers, power supplies, and motherboards. Try to absorb as much content as you can so you're prepared for it. Even before it arrives in your house, you should have a plan of action in your mind as to how you're going to build in it, from build order to what the finished product will look like.

Again, PC Part Picker is a key element here. In its building tool, it has a compatibility filter by default that will check certain compatibility issues, such as GPU length and case fitting, M.2 compatibility, memory frequency checks, BIOS compatibility, and more. It's not always right, and there are outliers for the more adventurous to take advantage of (the RMx Shift PSU for instance, rarely turns up as being compatible with any case), but it's a great starting point.

WHAT WOULD MAXIMUM PC DO?

Okay, let's bring all this together. In a world where we didn't have access to all the ridiculous hardware we do, what would we buy personally (I'm going to break the fourth wall here and *Maximum PC* tradition, and speak in first person)?

I've identified my budget of $2,000. I know thatI want a modern PC for gaming, at around 3,440x1,440 as my resolution. I play a ton of *Total War* and strategy games predominantly, but do dabble in the latest RPGs and other titles from time to time. I don't really do any rendering or professional work outside the odd bit of Photoshop, and I don't require a ton of storage. My home office doesn't have air conditioning, and although I'm on my PC for many hours at a time, it's usually doing light office work, so I don't need to worry too much about reliability, and can instead focus on aesthetics.

I'd also personally like a relatively compact tower. Here's what I'd buy: https://pcpartpicker.com/list/8kvGnp.

SYSTEM NOTES

I'm not going to be rendering hard, but I want a nice, versatile processor that runs

MODEL
05
GEFORCE RTX

Find a case that's got plenty of space for large motherboards, cable runs, and long graphics cards, and you should never have problems.

smooth. The Intel Core Ultra 5 245KF fits the bill for that. I know I'm always going to have a dedicated GPU, so going with the video-less KF is the cheaper solution.

For the motherboard, I've gone with a mid-range $260 Aorus Elite WiFi7. It's got really solid connectivity and a beautiful aesthetic, and will fit the overall theme. For memory, I'm pairing it with a 32GB kit of TeamGroup T-Create Expert (a current fave kit) at 6400 C32. I could have gone slower, but the cost saving wasn't really there, and if I want to swap to AMD long-term, these will still work nicely. C32 gives it a decent real-world latency, too. It's also low profile, which means I have one less RGB component to worry about.

For storage, I've splurged a bit here, mostly for my ego. Going with the T700 PCIe 5.0 drive for my OS drive, opting for this over the T705, as it's markedly cheaper, and performs close to parity on most tests, bar some sequential stuff that I don't really need it to (to be honest, even this is overkill). For my secondary 'games' drive, that's going to be managed by the NM710, again, a really great budget pick, but I could theoretically drop that to 1TB to save a touch of cash here too.

For my GPU, and because the RTX 50 series is still absent from the world, I've gone with the cheapest RTX 4070 Super I could find. There are aftermarket variants that shoot up almost by $200-300 more than this, but they will provide, at best, five to ten percent more performance, so MSI's Ventus 2X is perfect for that. It's also relatively compact, so I shouldn't have any case compatibility, and I know from online reviews (I'm roleplaying here; I've tested this card myself) that it's going to deliver roughly 50-100fps in the titles I play, which is comfortable for me.

Lastly, I've grabbed a slightly expensive Hyte Y40 chassis and combined that with one of Corsair's 2025 RM1000e PSUs. That comes with a 12VHPWR direct cable, a decent price, and has capacity for me to move up to an RTX 5080 at a later date.

The biggest splurge on the list is the Kraken Elite 280 RGB cooler. I've picked a 280 specifically, as it'll fit perfectly in the side vents on the Y40, filling that space, and will be more than ample enough to handle that Core Ultra 5's heat requirements.

FUTURE TWEAKS

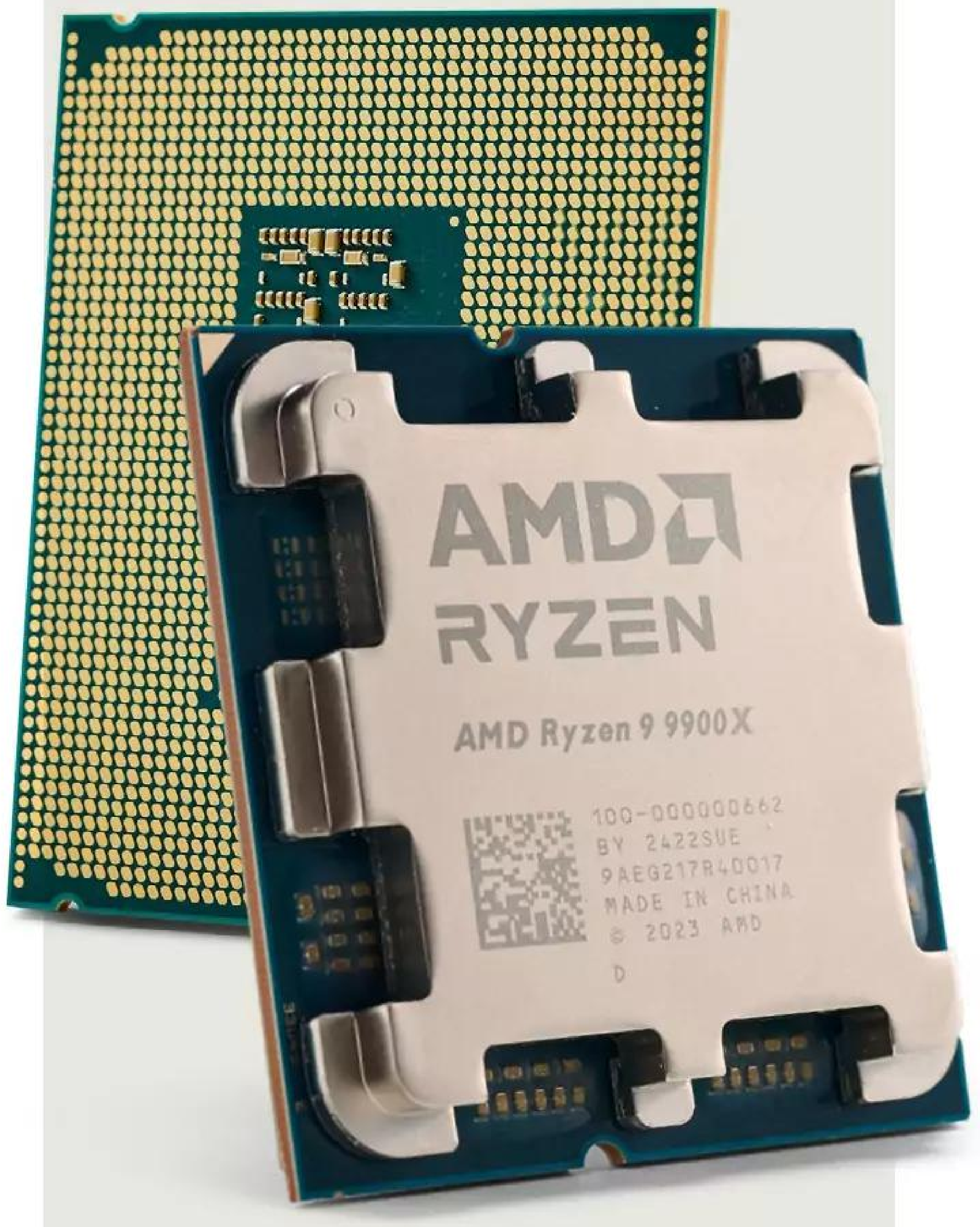
At a later date, I'd also like to get an extra NZXT RGB Core 360mm frame for the roof. As mentioned, there's capacity here for an upgrade to an RTX 5080, too. Alternatively, in a year or so's time, I may grab a new motherboard and CPU too, depending on how AMD's 10th series looks, and whether I really need to justify expanded USB connectivity.

INTEL VS AMD

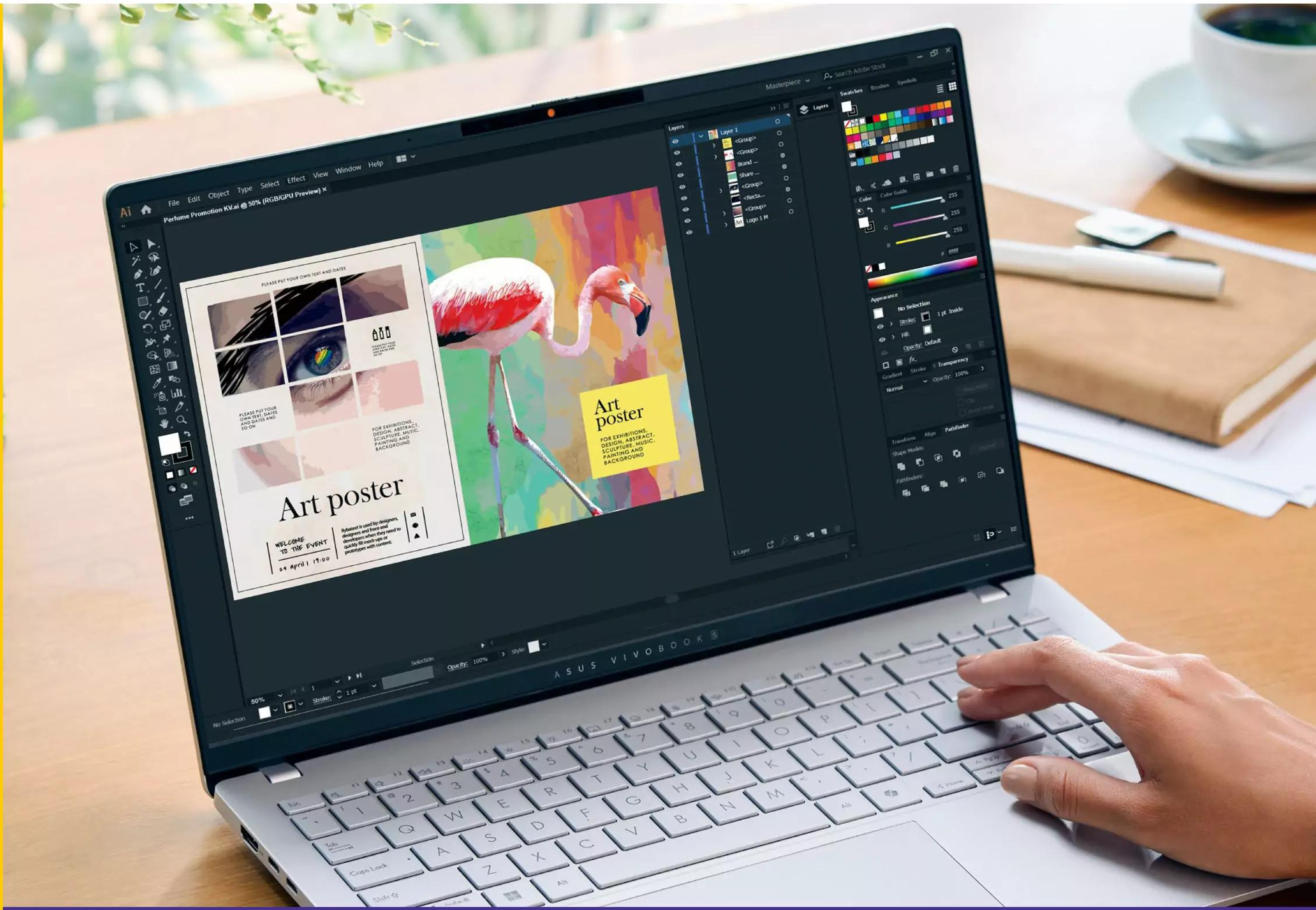
How do you pick between Intel and AMD when it comes to choosing your processor? The reality is there's very little difference between the user experience on both platforms. If you hid all the programs, all the hardware info and details, and put two blind systems side-by-side, you'd struggle to notice the difference.

Reliability, cost, general performance, connectivity all remain resolutely quite tight. Most of the differences come in the form of long-term compatibility, where AMD has the edge with its socket commitments, and unique workload scenarios, where some generations of processors perform better than others.

If you want the best multi-threaded performance, then AMD's X series chips are the way to go, although you'll be giving up some single-core power if you do. If you want the best gaming performance possible, then you want AMD's X3D processors, although again not every game will benefit from that 3D cache, and you'll lose out on a touch of high-end clock speed and multi-threaded performance. If you want general all-around solid performance, but not class-leading in any one particular field, then Intel's Core Ultra line-up is the one you should consider.



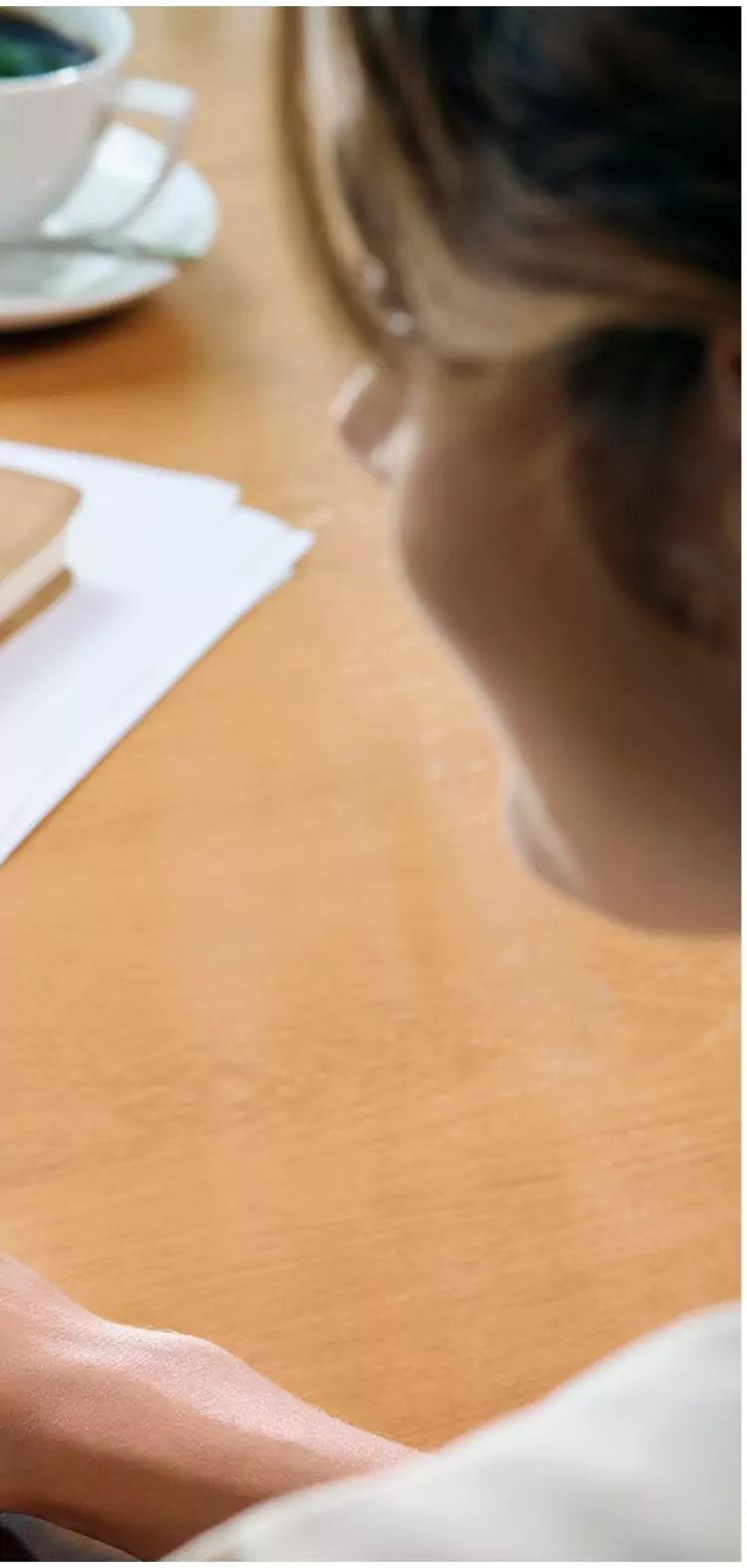
Which do you choose: Intel Core Ultra 5 245K or AMD Ryzen 9 9900X? The answer couldn't be simpler.


Art poster
Art poster
ASUS VIVOBOOK

EMULATION

MAKING WINDOWS ON ARM GREAT AGAIN

How do the latest laptops and Macs run Intel software on their ARM processors? *Darien Graham-Smith* explores the wonderful world of emulation



MICROSOFT'S 'COPILOT+ PCS' are supposed to usher in a new era of AI-assisted computing, but they're historic in another way, too. With surprisingly little fanfare, Microsoft has for the first time endorsed a range of third-party laptops based on a mixture of AMD, Intel, and ARM processors.

This isn't the first time it has offered a version of Windows that runs on ARM architecture, but it might be the first time the idea succeeds—as the OS now has an emulation layer. Conceptually, this is much the same as the software tools that let you tinker with a virtual BBC Micro inside a web page, or revisit Amiga games on your phone. In this case, it's designed not for historical purposes, but to allow the latest Intel-native apps to run on the ARM hardware.

It's a similar approach to what Apple did with the launch of its M-series processors, and it promises the best of all worlds, combining Windows' huge existing software library with the efficiency and battery life of ARM. If you're curious as to how we've got here, and what emulation could mean for your next laptop, read on.

© ASUS, MICROSOFT

The Surface Pro 11th Edition is powered by Snapdragon chips.

NO EMULATION, PLEASE—WE'RE WINDOWS

Microsoft has a long history of developing Windows for multiple different hardware platforms. In the 1990s, you could buy versions of Windows NT not only for the familiar Intel x86 platform, but also for rival workstation and server systems, such as PowerPC, DEC Alpha, and MIPS—each with its own proprietary instruction set architecture (ISA). In the early 2000s, support was added for Intel's 64-bit Itanium platform, too.

However, Microsoft made no attempt to bridge the gap between these different platforms. Each edition of Windows only worked with software and drivers that had been compiled for that particular architecture. The result was a highly fragmented market that wasn't ideal for anybody—certainly not Microsoft, which was at one point simultaneously developing and supporting Windows for at least five different hardware platforms. Partly for this very reason, the competing ISAs gradually died away, and by 2010, Windows was only available for the Intel architecture.

Remember the Surface RT, Microsoft's first attempt to put Windows on ARM?

THE WOW64 STARTS NOW

Ironically, while Microsoft was jettisoning non-Intel architectures, it rapidly found itself having to build new emulation features into Windows. In 2000, AMD introduced the AMD64 architecture, an extension of Intel's x86 ISA that enabled support for 64-bit addressing—meaning PCs could use more than 4GB of RAM, and work more quickly and efficiently with larger data structures.

At first, Microsoft ignored AMD64, seemingly believing that the 64-bit future lay with the Intel Itanium architecture. But while IA-64 was a completely new ISA that couldn't run x86 apps, AMD64 included native support for 32-bit versions of Windows and applications, making it a much more attractive choice for general-purpose computing. By 2004, Intel had started licensing AMD's 64-bit extensions for use in its own x86 chips under the not very imaginative name 'Intel 64'. Itanium fell by the wayside, and the new x86-compatible 64-bit platform—now commonly known as x86-64, or just x64—started to become ubiquitous.

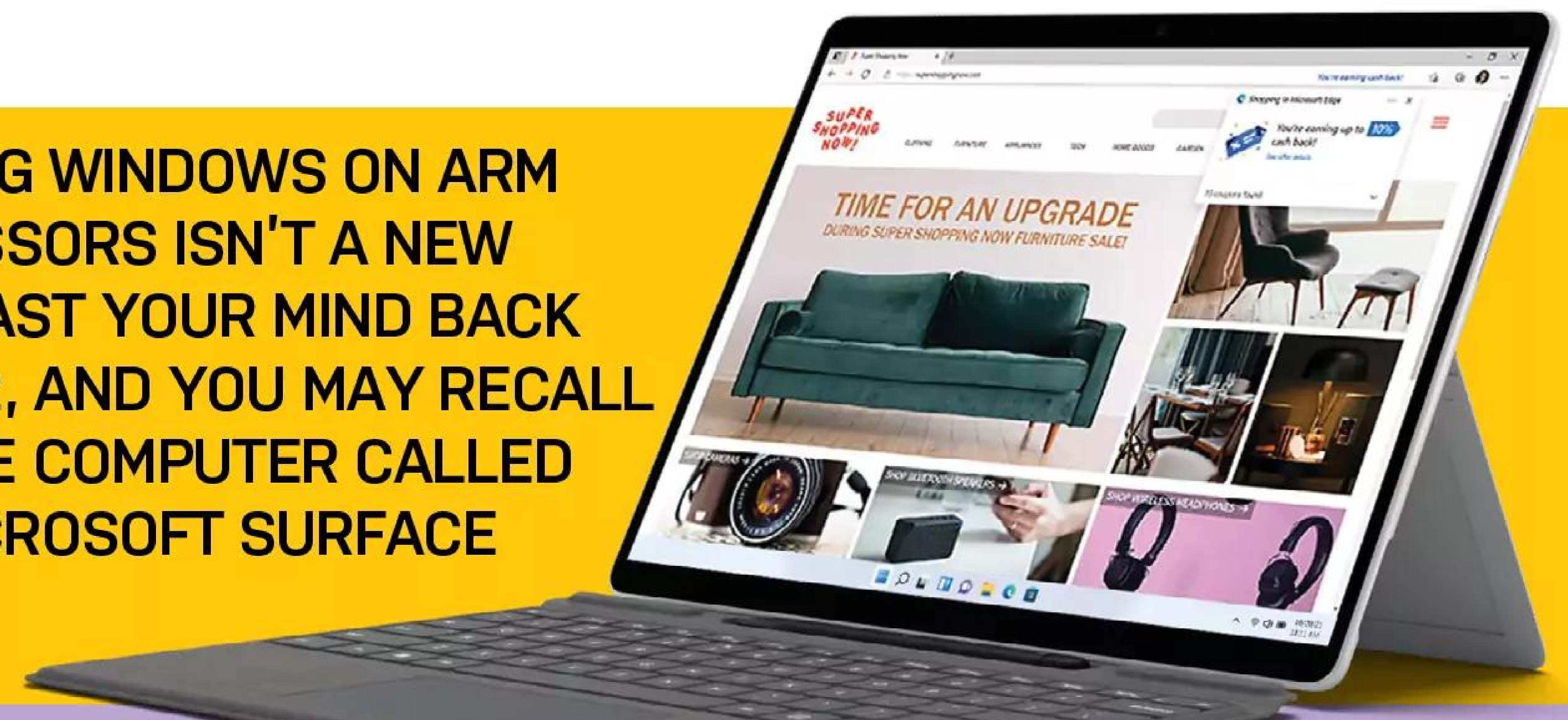
You might be wondering: if the whole point of x64 was compatibility with older x86 code, where does emulation come in? The answer lies in the interaction between the OS and the hardware. Taking advantage of the chip's 64-bit capabilities required a 64-bit edition of Windows: the first of these was Windows XP Professional x64 edition, released in 2005. From Vista onward, all releases of Windows were offered in both x86 and x64 flavors.

But because 64-bit Windows used larger address spaces, additional registers, and other extensions, it wasn't directly compatible with programs designed for the 32-bit version. For older applications, Microsoft designed an emulation system called WoW64 (Windows-on-Windows 64-bit), on the same lines as the old WoW32 component in Windows NT that allowed the 32-bit OS to run old 16-bit applications.

The WoW64 framework includes a set of libraries that translate 32-bit operations into 64-bit compatible forms, and automatically 'redirects' certain operations to keep 32-bit and 64-bit components apart. For example, when 32-bit apps try to access the Registry, the OS redirects operations to a separate

32-bit datastore, and 32-bit apps install and run in a folder called 'Program Files (x86)'—aside from the main 'Program Files' folder, which is reserved for 64-bit code. The actual program code, however, runs on the processor unmodified, so there's almost no impact on performance or system resources.

RUNNING WINDOWS ON ARM PROCESSORS ISN'T A NEW IDEA. CAST YOUR MIND BACK TO 2012, AND YOU MAY RECALL A LITTLE COMPUTER CALLED THE MICROSOFT SURFACE



The Surface Pro X gave Windows on ARM a new lease of life.

© MICROSOFT

WINDOWS ON ARM

You could make a case for WoW64 being the world's most popular emulation layer, since it's included in almost every copy of Windows in use. However, it's not exactly ambitious, and some say it barely qualifies as emulation, since rather than emulating a CPU, it emulates a different version of Windows. The same can't be said for Microsoft's most recent emulation project, which aims to allow Windows apps written for the Intel architecture to run smoothly on a computer with an ARM processor.

Running Windows on ARM processors isn't new. Cast your mind back to 2012, and you may recall the Microsoft Surface. This was built around an ARM-based Nvidia Tegra 3 T30 chip, and ran an ARM-based version of Windows called Windows RT.

At first glance, you could mistake Windows RT for Windows 8. The two were launched simultaneously, and offered nearly identical interfaces. However, as with previous non-Intel editions of Windows, RT could only run applications compiled for its hardware platform. You couldn't even install Intel apps, as the Surface was restricted to software offered via the new Windows Store.

Microsoft spun these restrictions as a plus point: viruses and other security threats wouldn't work on the new platform, and the sandboxed Store framework helped block new exploits. The simpler, cleaner app model also meant the operating system could be more streamlined and efficient. Even so, the lack of compatible software made RT a lame duck, and when Windows 10 was released in 2015, the ARM platform was dropped. It seemed as if the idea of Windows on ARM might be dead forever.

Clearly, though, it wasn't. In the following years, Intel went through a period of stagnation, while ARM chips became faster and more energy-efficient. In 2019, Microsoft unveiled a new sort of Windows device dubbed the Surface Pro X. Rather than being a lightweight cousin to the Surface Pro, like the original Surface, the Pro X was positioned as a slick and stylish alternative, with a sexy name and full-sized screen. It featured a new ARM-based Microsoft SQ1 processor, developed in partnership with Arm veterans Qualcomm.

Most significantly, it ran a new ARM-native build of Windows 10, known as WoA. As with Windows RT, it looked and felt almost identical to the Intel version—but for the first time, it included a real-time emulation layer allowing Intel apps to install on this non-native hardware.

THE LONG AND WINDING ROAD

Even in the first edition of WoA, the Intel emulation layer was pretty seamless. Unlike Windows RT, the OS allowed you to freely download and install software from anywhere, with the Windows Store and other software distribution tools serving up ARM packages where they were available, or falling back to Intel if they weren't. Programs compiled for Intel would automatically run in emulation mode alongside native apps, and you normally wouldn't even know it was happening: as with WoW64, the apps themselves didn't know they were running under emulation unless they'd been coded to detect it. The main thing that couldn't be emulated was low-level device drivers, so if you wanted to use weird and wonderful hardware devices, or play games designed for high-end GPUs, you'd need to use ARM-native software.

In the initial WoA release, however, there was one other limitation. Although the Surface Pro X system was 64-bit through and through, the bundled Intel emulator only supported 32-bit x86 apps; anything for x64 wouldn't run.

This immediately ruled out the latest versions of many applications—after all, 64-bit Windows was at this point 14 years old. It also meant that although the Surface Pro X came with 8GB of RAM as standard, no more than half was accessible to any x86 app. Even if an x86 app would run, emulated performance could be laggy: the emulator was a work in progress and, unlike Apple's M-series processors, the SQ1 chip lacked any custom silicon designed to speed up the translation from one ISA to another (it was basically a lightly tweaked version of Qualcomm's general-purpose Snapdragon 8cx).

Thankfully, only early adopters using Windows 10 on ARM had these issues. Windows 11 was developed as a dual-platform OS, and the ARM edition introduced an emulation layer that's fully compatible with 64-bit code, along with a new hybrid emulation model—a framework called Arm64EC ('emulation compatible'), which lets programs use a mixture of native ARM code and x64 components. This means developers can build mostly ARM-native programs that only use emulation for OS components that aren't directly supported on ARM, allowing for performance gains without requiring deep refactoring. If you're curious which mode a program is running in, open the Task Manager and check the 'Architecture' column: this will show 'x86' for emulated code, 'ARM64' for native processes, or 'ARM64 (x64 compatible)' for Arm64EC.

GETTING BETTER

As well as a new emulation platform, Windows 11 has seen

HOW APPLE BRIDGED THE GAP

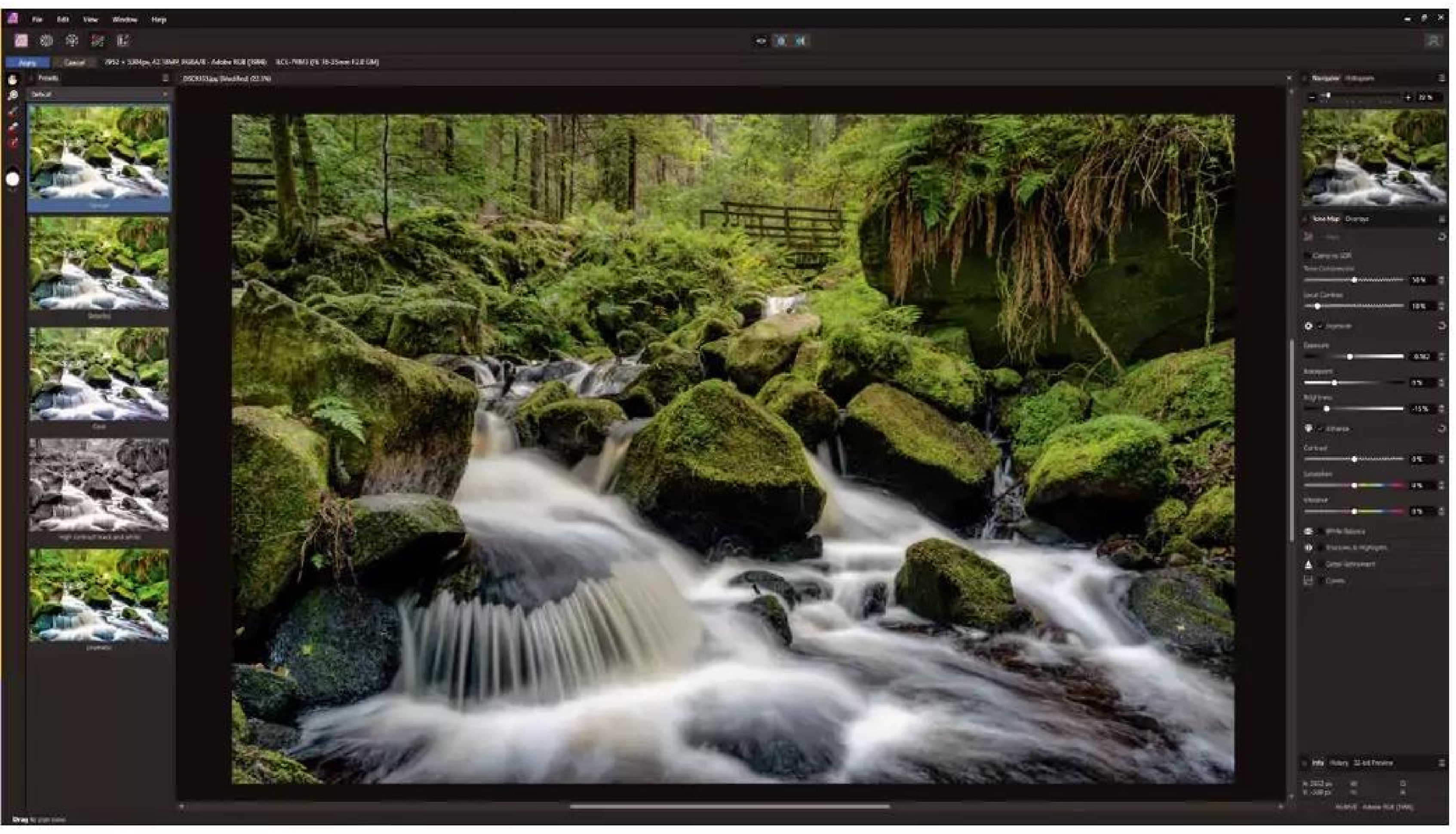
It's almost impossible to talk about platform emulation without mentioning Apple, a company that has used emulator technology not once, but three times in its history to pull off major platform moves. The most recent, of course, was with the launch of its own-brand M-series processors, based on a licensed implementation of the ARM architecture. The new design offered better performance and power consumption than the Intel chips the company had previously been using, but since the Intel architecture had been the status quo for the previous 15 years, when the M1 came along in 2020, it was incompatible with almost every Mac application in existence.

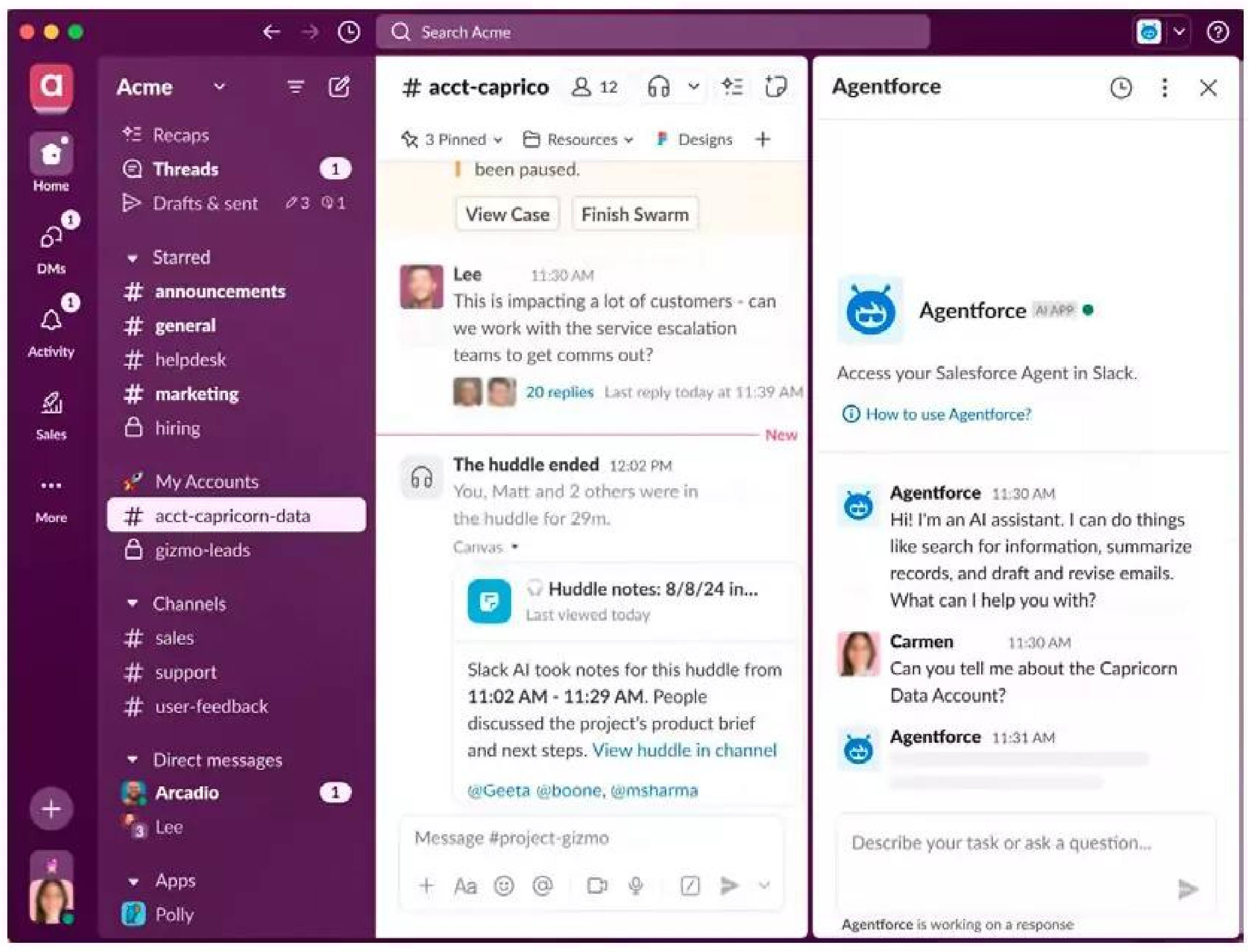
Apple's solution was to create a new emulation framework built into the ARM-based version of macOS, which enabled existing apps to run on the new hardware by dynamically translating Intel code into ARM-compatible instructions and calls. Strictly speaking, this is an optional component of the OS, which is downloaded the first time you run an Intel application, but we doubt that there are many Macs out there that don't have it installed.

The decision to use emulation wasn't exactly a shock—Apple had previously made a similar move back in 1994 when it chose to migrate away from the Motorola 68000 architecture that had powered the first generation of Macintosh computers, switching to the newer PowerPC platform developed in partnership with IBM and Motorola. A decade later, Apple switched again, from PowerPC to Intel—and again provided an emulation component called Rosetta, in honor of which the current emulation framework for ARM is often referred to as Rosetta 2 (although Apple itself just calls it Rosetta).

The clever thing about Rosetta 2 is that it's not purely a software solution. As well as using clever code-translation routines, Apple has taken advantage of the fact that it creates its own chip designs to build in custom hardware that replicates the way Intel processors handle memory access. This slashes the amount of data reordering that needs to be done in software, so legacy apps generally feel as smooth and responsive under emulation as they did on native Intel silicon.

In 2025, though, the significance of Rosetta 2 is dwindling. Since Apple no longer sells Intel Macs in any form, almost every modern application is now ARM-native, and it's rumored that Apple will stop supporting Rosetta 2 next year.





been paused.

Lee 11:30 AM
This is impacting a lot of customers - can we work with the service escalation teams to get comms out?
20 replies Last reply today at 11:39 AM

New

The huddle ended 12:02 PM
You, Matt and 2 others were in the huddle for 29m.
Canvas •
Huddle notes: 8/8/24 in...
Last viewed today
Slack AI took notes for this huddle from **11:02 AM - 11:29 AM**. People discussed the project's product brief and next steps. View huddle in channel
@Geeta @boone, @msharma

Message #project-gizmo

Agentforce AI APP
Access your Salesforce Agent in Slack.
How to use Agentforce?

Agentforce 11:30 AM
Hi! I'm an AI assistant. I can do things like search for information, summarize records, and draft and revise emails. What can I help you with?

Carmen 11:30 AM
Can you tell me about the Capricorn Data Account?

Agentforce 11:31 AM

Describe your task or ask a question...

Agentforce is working on a response

Apps such as Affinity Photo, Slack, and Zoom are available for WoA.

© AFFINITY PHOTO, SLACK, ZOOM

an explosion of hardware options, with the first wave of Copilot+ PCs offering ARM-based Windows laptops from both Microsoft and third-party manufacturers, all based on Qualcomm's Snapdragon X chips. You might rarely even need emulation. Almost all the biggest apps are available for Arm: Qualcomm's website namechecks native WoA packages, including Adobe Photoshop, Affinity Photo, CapCut, Cubase, DaVinci Resolve, Dropbox, Slack, Zoom, most major browsers, and a wide range of security and VPN software (tinyurl.com/365armapps). A Microsoft survey found that more than 90 percent of 'total app minutes' on an ARM-based Copilot+ PC were spent using Arm-native software.

While no partnership has been announced, from the original Surface Pro X to the latest Copilot+ PCs, every WoA device has used a Qualcomm processor. It's understood that Qualcomm has been involved in the development of the emulation layer, so it's being developed by those best placed to understand the chip architecture, and continue to optimize translation.

The Windows 11 24H2 update for ARM processors introduced a new version of Prism, its emulation layer. As well as supporting the Intel instruction set, Prism emulates several optional x64 CPU extensions, including AVX2, BMI, and FMA, which can accelerate types of data operations while reducing energy consumption by using dedicated hardware. Microsoft's support pages on emulation note that "some performance features within Prism require hardware features only available in the Snapdragon X series". In other words, WoA is starting to benefit from hardware optimizations.

There's one big difference: while Apple has historically used emulation to smooth over a wholesale switch from one platform to another, there's no suggestion that Microsoft is planning to ditch Intel support. Rather, the expectation is that Windows will support both x64 and Arm platforms indefinitely, so you can pick the model that best suits your needs, without having to worry about what sort of processor it has inside.

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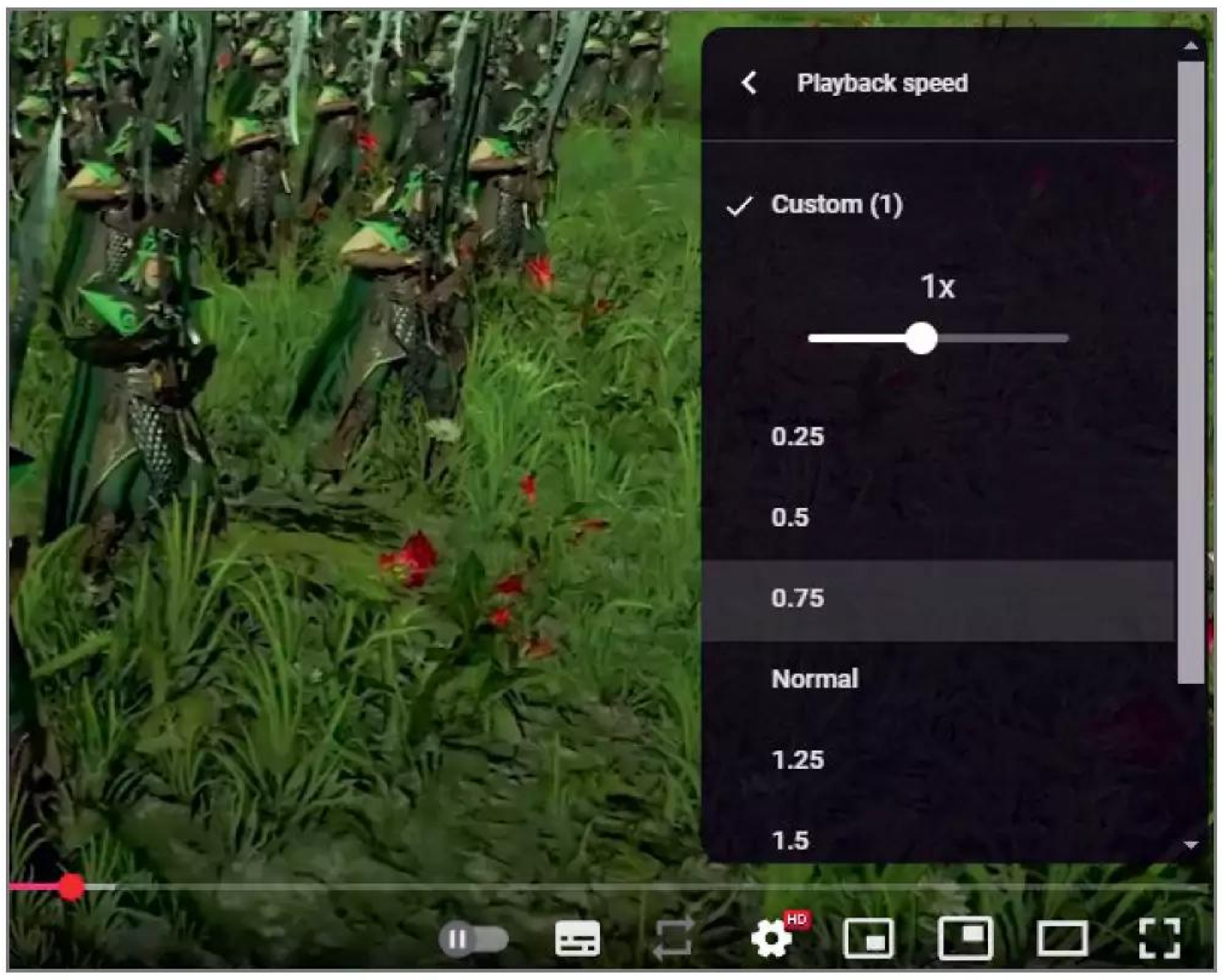
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



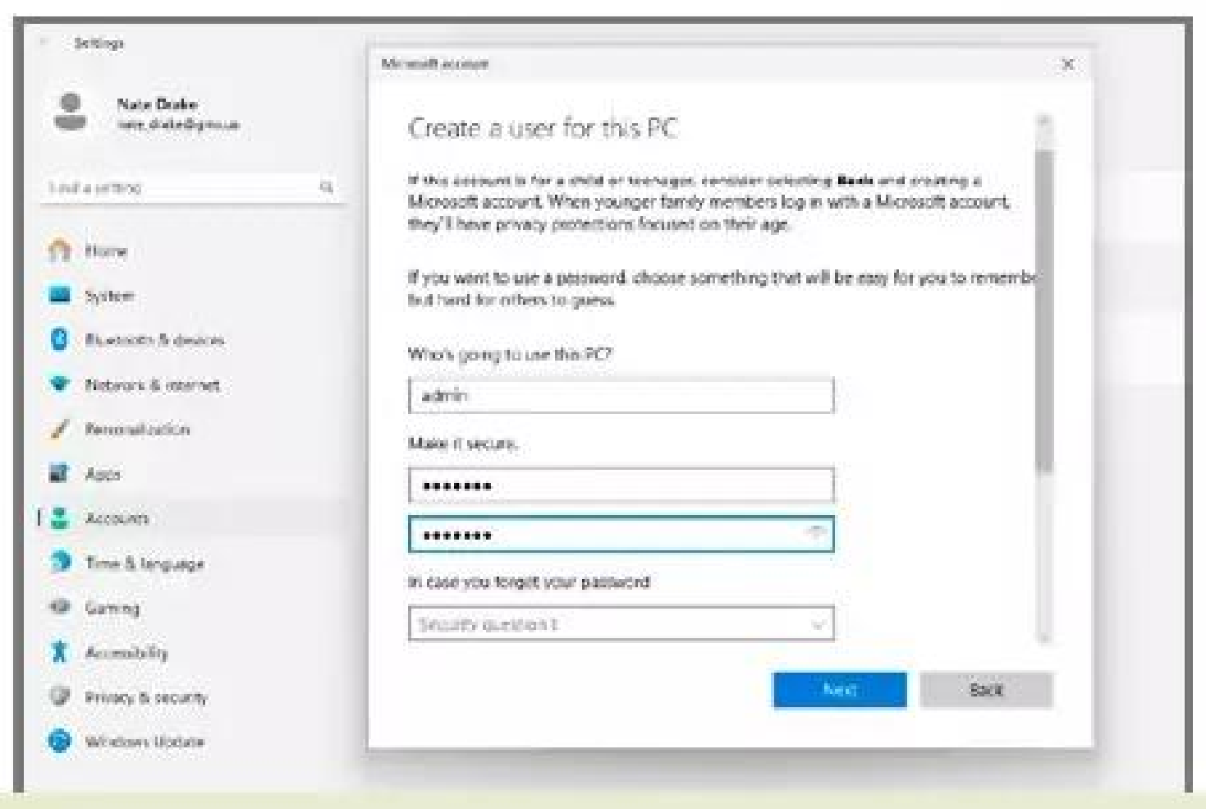
SPEED UP YOUTUBE VIDEOS

YouTube is a fantastic platform to find some top-quality educational content, but if you're short on time, it can be slow to digest video content. Speed things up and absorb that knowledge faster by adjusting playback speed. Click settings, then Playback speed, and adjust to 1.25x or 1.5x speed. Be warned, though: once you go faster, it's hard to go back.

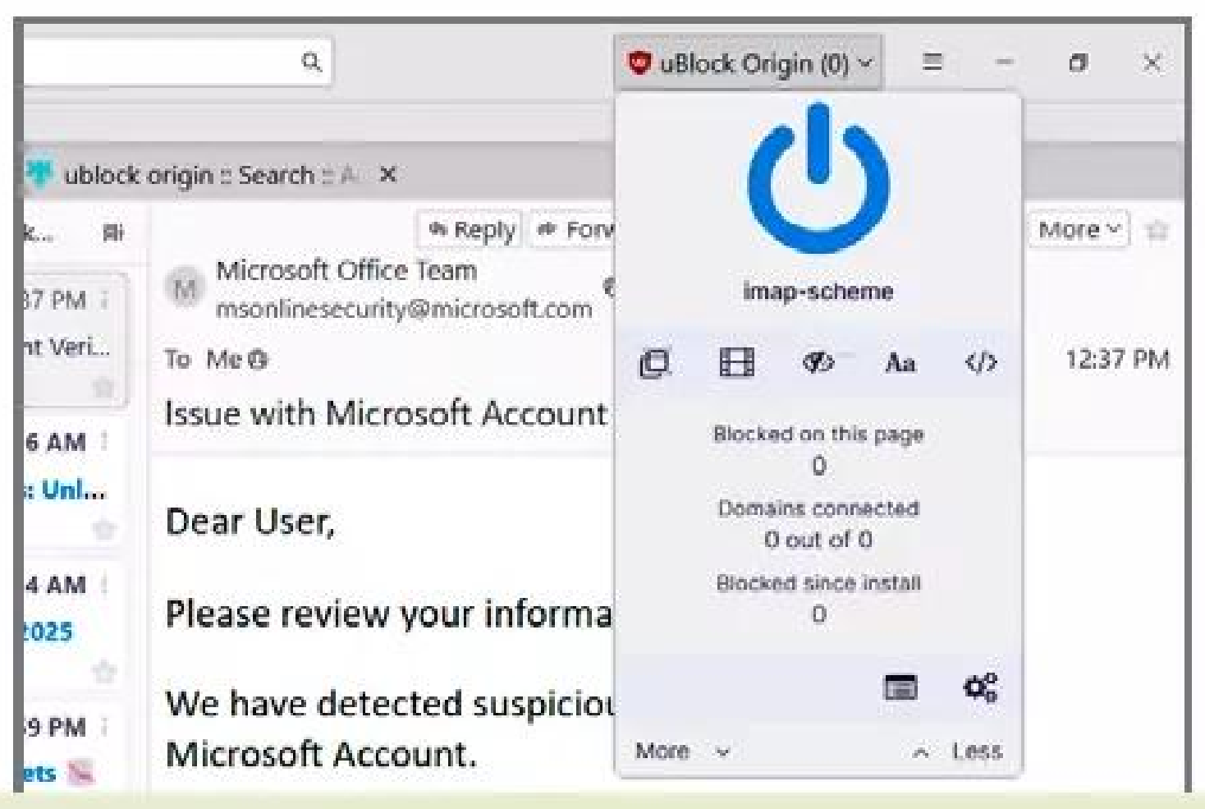
MAKE – USE – CREATE

Here is the steampunk version of Tux the Linux penguin you requested! Let me know if you'd like an modifications or additional details.

60
How to use
ChatGPT Projects



62
Tweak Windows
11's privacy settings


uBlock Origin
Microsoft Office Team
Issue with Microsoft Account
Dear User,
Please review your informa
We have detected suspiciou
Microsoft Account.

64
Spot phishing
emails

© YOUTUBE, CHATGPT, MICROSOFT, UBLOCK ORIGIN

ZAK STOREY
CONTRIBUTOR

TOP BUDGET CHASSIS

I recently had the pleasure of building inside a rather bizarre chassis: the Gamemax F46 BK. You can tell it's an entry-level Chinese brand (apparently Colorful, the GPU maker, is its parent company), but regardless, it's an ATX mid-tower design, with some quite curious design decisions behind it.

For instance, the power supply was mounted in the roof at the back of the case, with dubious-looking CPU power cutouts that required me to effectively attach the EPS power cables to the motherboard even before I installed it. It also came with four daisy-chained RGB fans. The GPU had an adjustable anti-sag support bracket baked into the motherboard tray that you could tweak, plus it was BTF ready.

Don't get me wrong, you could tell where the corners were cut; the cable grommets were challenging, the spacing in places was tight, and the overall feel and finish were very entry-level, and that's being quite kind at that.

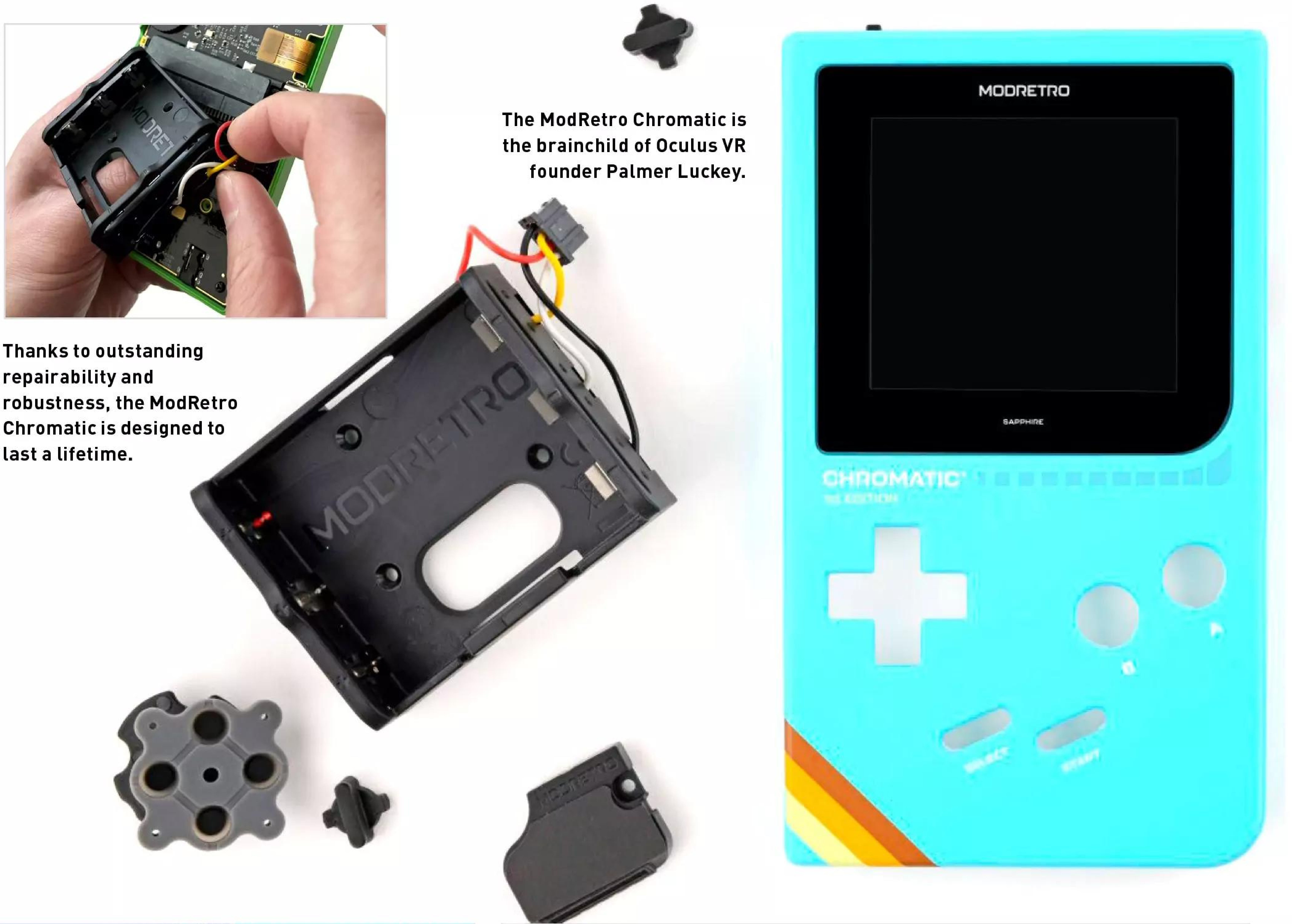
The thing, it gave me a deep hit of nostalgia. It reminded me what building PCs was like back in the early 2010s and late 2000s; immensely satisfying. It was challenging, but in such a positive way. PC building has come such a long way, it's easy to forget where we've come from.

↘ submit your How To project idea to: editor@maximumpc.com

IFIXIT presents:

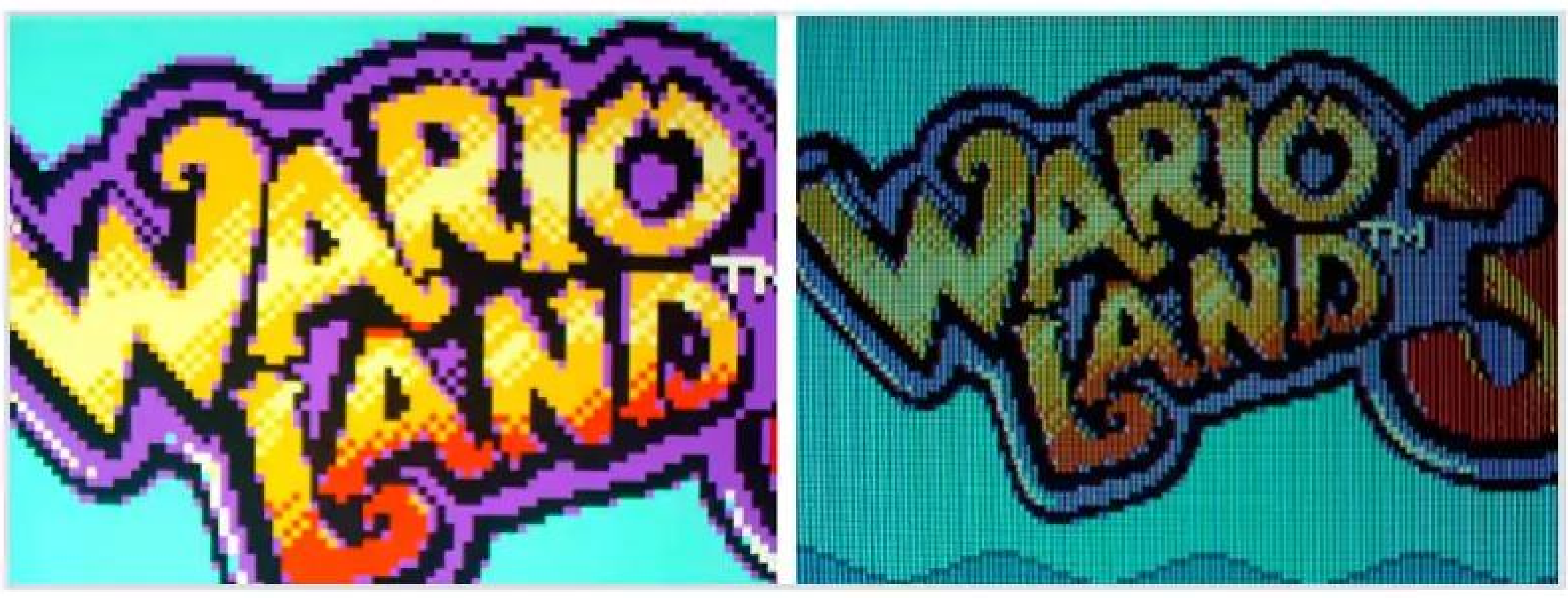
AUTOPSY

THIS MONTH WE DISSECT...

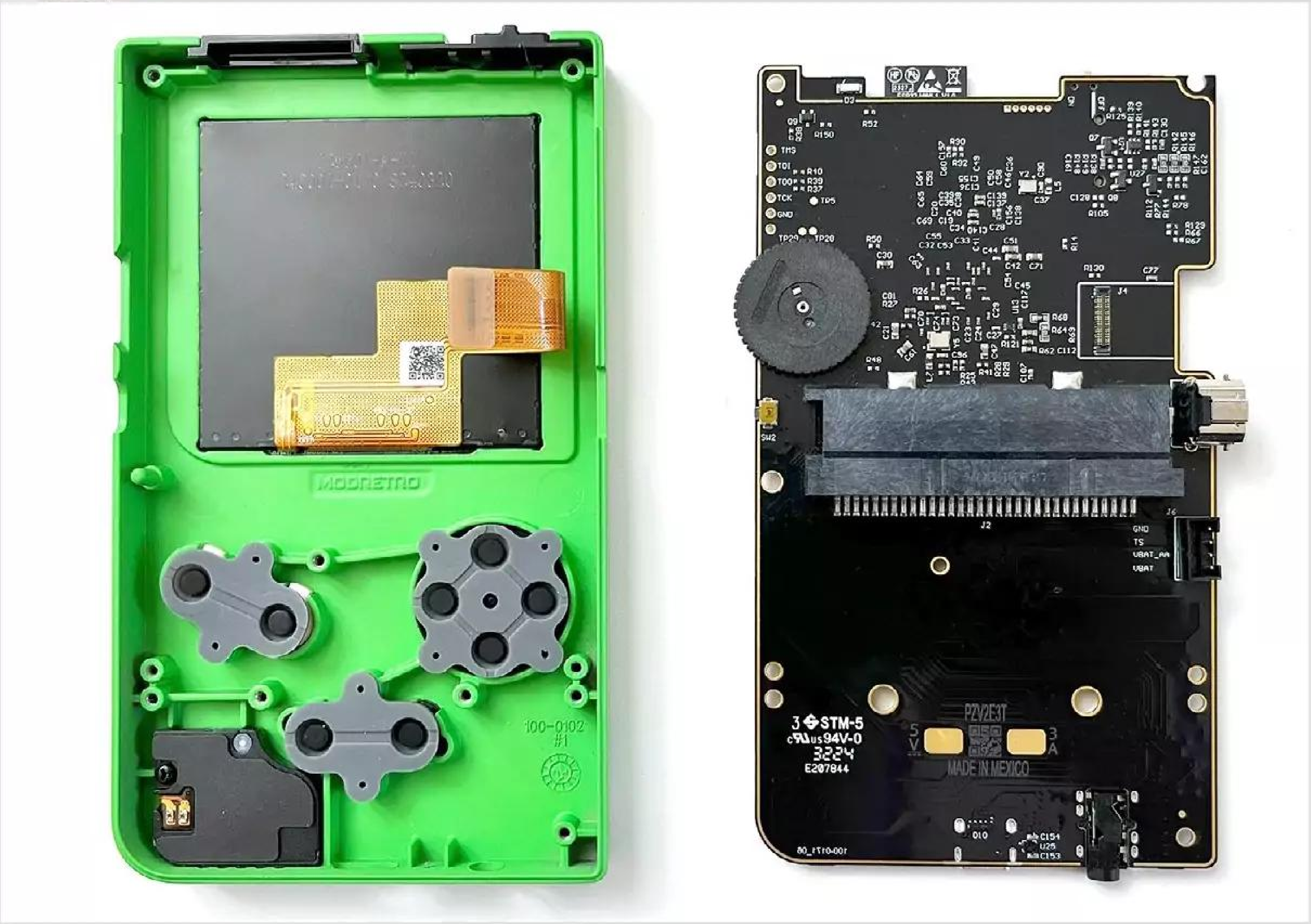


The ModRetro Chromatic is the brainchild of Oculus VR founder Palmer Luckey.

Thanks to outstanding repairability and robustness, the ModRetro Chromatic is designed to last a lifetime.



Generic emulator (left) versus the ModRetro Chromatic (right). There's no denying that one of these LCD panels runs at a much higher resolution.

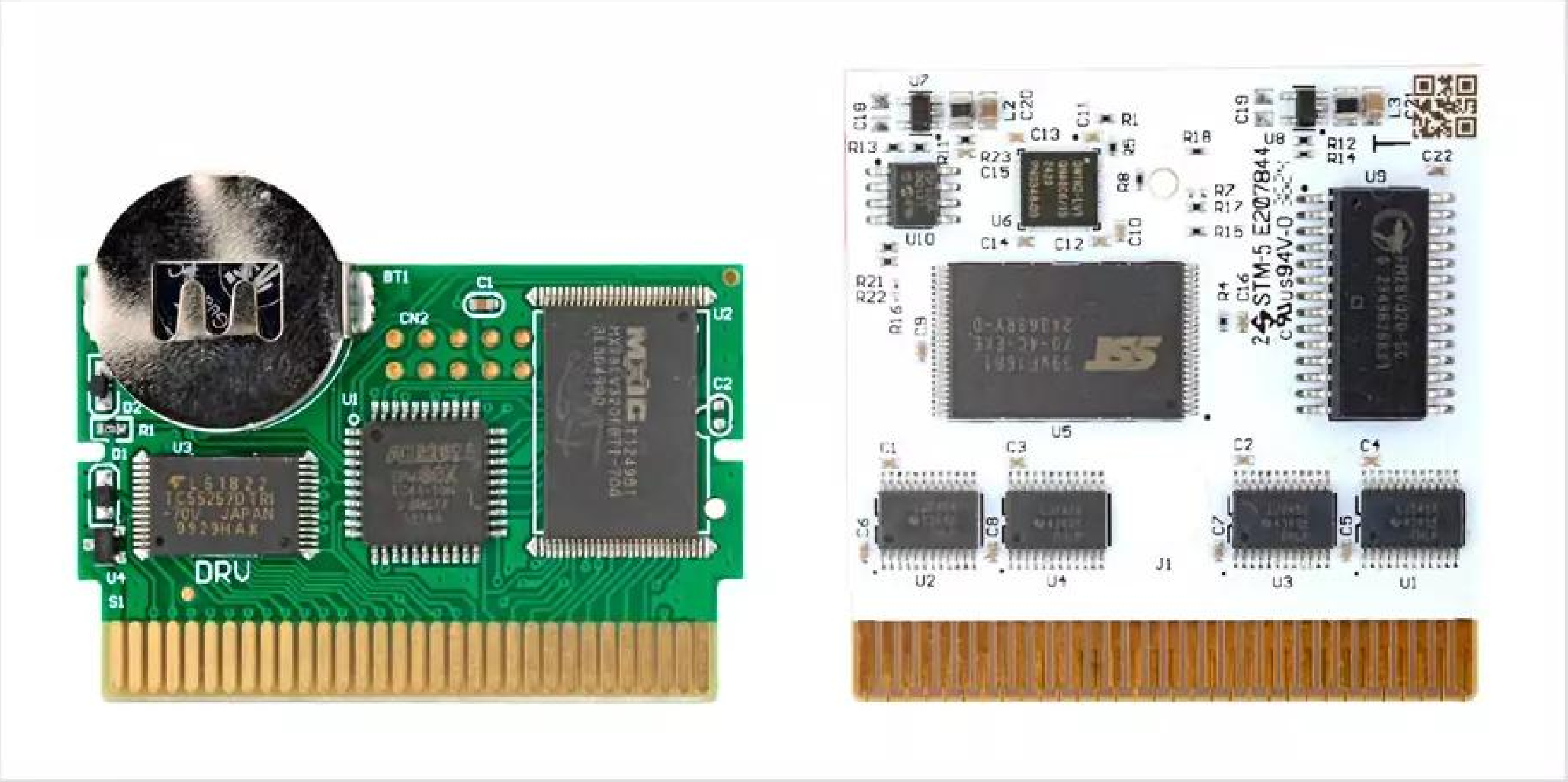


About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com

The ModRetro Chromatic is a new entry in the handheld gaming space that might remind you a little bit of something from the past.

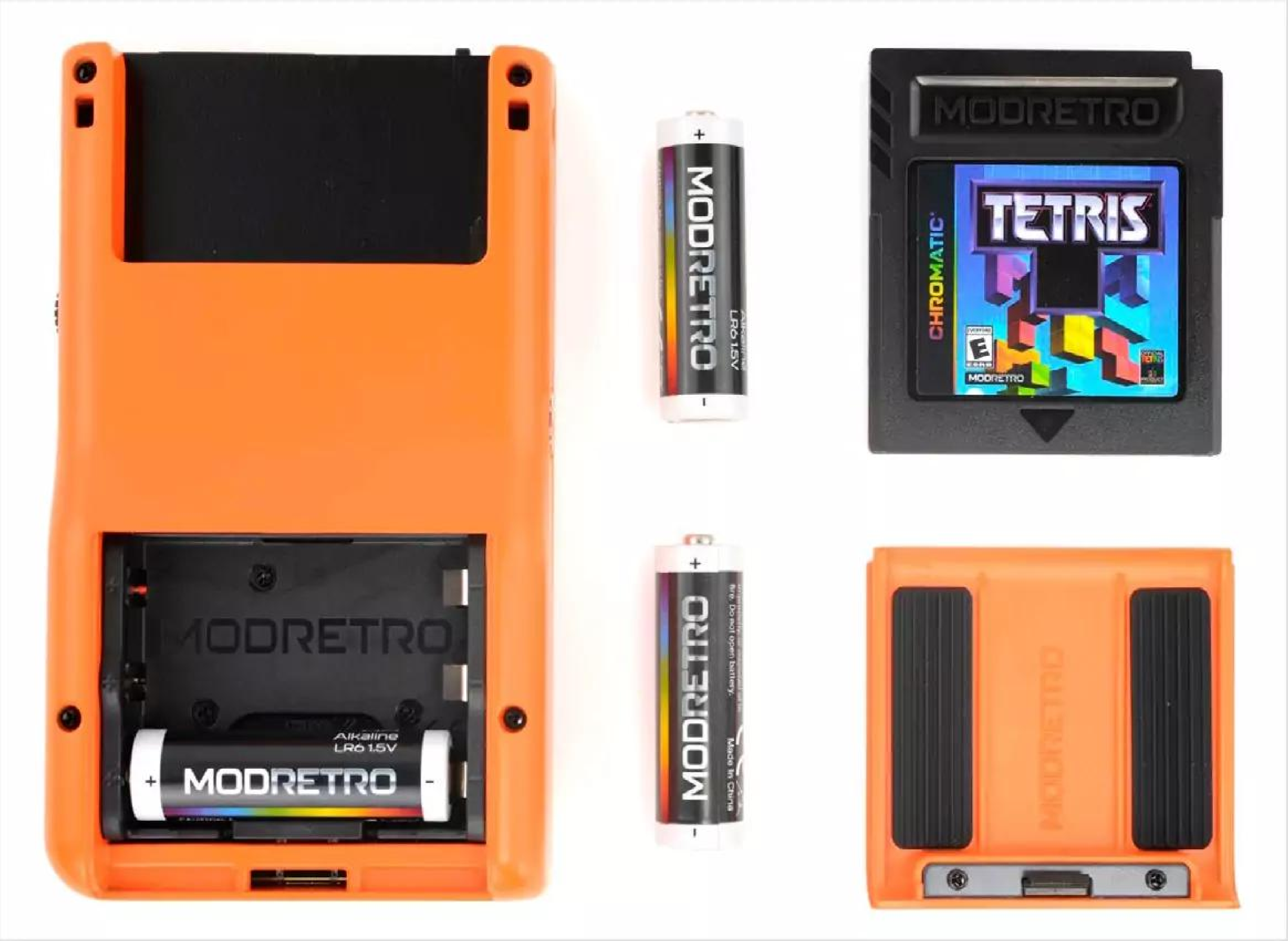
ModRetro Chromatic



Modern Tetris cartridge (right) next to a counterfeit game cartridge using static SRAM with battery (left).

Below: Full compatibility with Game Boy and Game Boy Color game cartridges is a key feature.

Below left: USB-C port sitting just above the battery compartment on the lower edge allows the device to operate on external power.



BACKGROUND

The ModRetro Chromatic is a new retro handheld games console that hits you hard in the nostalgias. It emulates the Nintendo Game Boy Color, a device that's now well beyond its service life, plays all the classic cartridges and it's built with longevity and repairability in mind.

MAJOR TECH SPECS

- 160 x 144 pixel 2.56-inch IPS backlit LCD
- FPGA-based architecture
- Backwards compatible link cable port
- USB-C lagless video out
- 3.5mm headphone output
- Compatible with Game Boy and Game Boy Color game cartridges
- Magnesium alloy thixomolded shell
- 3x AA batteries or custom lithium ion pack

KEY FINDINGS

- The Chromatic's electronics are seemingly antithetical to the three-decade-old hardware it emulates, and nowhere is this more evident than when comparing the modern IC BGA solder points to the bulky through-hole components that are visible on the original Game Boy.

- While capable of supporting an optional lithium ion battery pack, the device is designed to run off three AA batteries (included in the box) via an easy-access latched compartment on the back. Not happy with the AA batteries or the lithium ion pack? That's fine, too! So long as you're outputting around 4.5V, you can hook in salt batteries or a miniature nuclear reactor for all the device cares.

- The screen, it turns out, is a rare example of a fully custom LCD manufactured using modern techniques to mimic the obsolete LCDs used in the Game Boy Color. This was done with the firm belief that it would be impossible to recreate a true Game Boy Color facsimile without getting the display right.

- The magnesium alloy frame is sturdy, and undoubtedly a step up from the original Game Boy's plastic shell, a material choice that ensures the Chromatic won't yellow or stain like the crusty plastic consoles of yesteryear.

- It's not just the quality of the build that makes this device long-lasting; ModRetro has already released 3D printable CAD files for the mechanical components, a repair guide on iFixit's website, and has committed to releasing spare parts for the electrical components.

- The battery terminals and speaker were particular pain points on the original Game Boy, requiring basic soldering skills to perform these repairs. With a couple of notable exceptions—specifically the USB-C and Game Link ports—the highly modular design on the Chromatic makes significant strides towards ensuring that the end user is able to fix the device with a minimum set of tools and skills. This is the kind of device that you can buy once and keep forever, and it's from this perspective that the $200 price tag should be viewed.

- Repairability Score: Score: 10 out of 10 (10 is easiest to repair). The only fault with the ModRetro Chromatic is the use of tripoint screws, a stylistic decision made to match the original Game Boy and Game Boy Color devices. Highly repairable and robust, this is a very rare device that's made to be bought once and kept for life.

How to use ChatGPT Projects

YOU'LL NEED THIS

CHATGPT
A ChatGPT Plus Pro, or Teams subscription.

THE FREE VERSION OF CHATGPT can be an excellent way to help you keep tasks on track. You can create and save ongoing 'chats' related to your work, as well as analyze individual files.

Still, if you have a serious undertaking such as a wedding, vacation, or hobby then the basic version of ChatGPT can struggle to manage multiple conversations and files.

This is where ChatGPT 'Projects' is useful. At its core, it's a way to centralize all conversations and files. You can even add custom instructions to explain the nature of your project and what you're planning. Projects also has a dedicated section to upload unlimited numbers of files.

In this tutorial, we'll focus on how to max out your workflow by setting up your first ChatGPT project. You'll also learn how to add and generate conversations, analyze files, generate images and code, and manage project data. **–NATE DRAKE**

1 SET UP YOUR PROJECT

To start using ChatGPT Projects you'll need to be logged in to either the main site (https://chatgpt.com) or be using the official app, which is available in the Microsoft Store.

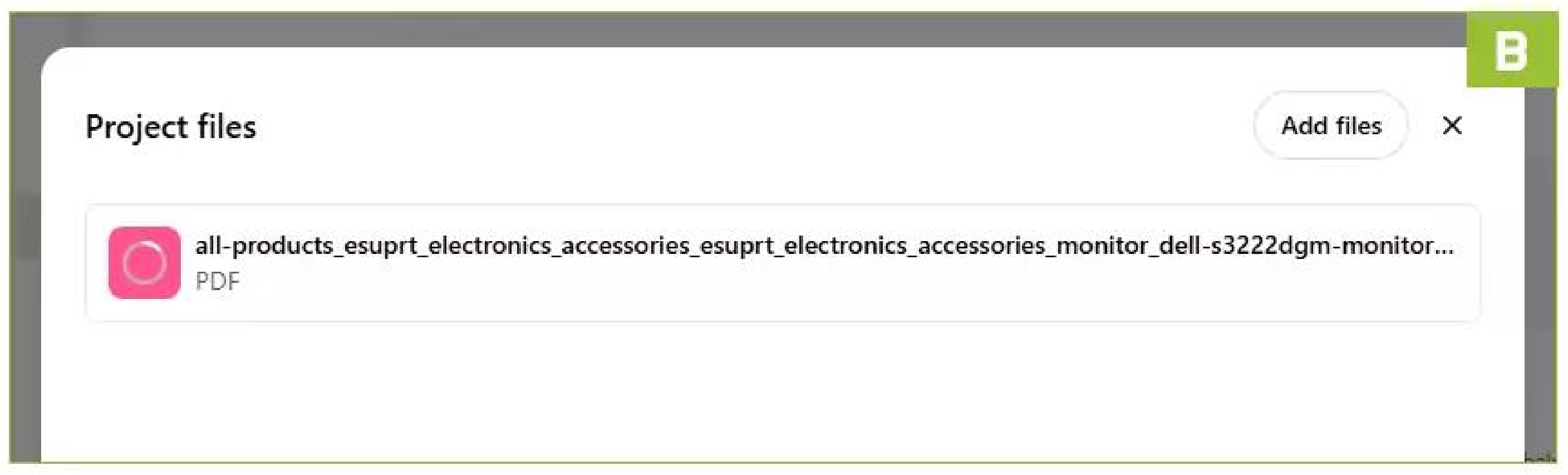
» Currently, the Projects feature is only available to Plus, Pro, or Teams users. If you're using the free version of ChatGPT, you'll need to upgrade. You can do this from the website by clicking your profile avatar at the top right of the screen and choosing 'Upgrade Plan'. 'Plus' subscriptions are $20 per month before tax.

» Entering your debit/credit information is simple, but during our tests, we found that we had to disconnect from our VPN for the payment to be processed.

» Once the upgrade is complete, you'll see a new section in the ChatGPT sidebar entitled 'Projects'. Select 'New Project' to begin. You'll now be asked to enter a name for your project, eg. 'Building my Dream PC.' Click 'Create Project' to continue.

» Once the project loads, choose 'Add Instructions'. As the site explains, this allows you to add prompts to tailor ChatGPT's responses. For instance, for building your dream PC, you could instruct the AI to keep answers factual and concise. You also may ask it to provide specifications and pricing for components where possible. [**Image A**]

» Once these changes are saved, it's time to start adding some content of your own. In the case of our 'Dream PC' project, we'd already asked ChatGPT about the best gaming monitors on the market right now. If you have existing conversations like this that are relevant to the current project, drag and drop them into the main window from the side bar. These will now appear under 'Chats in this project'.



Project files

Add files

all-products_esuprt_electronics_accessories_esuprt_electronics_accessories_monitor_dell-s3222dgm-monitor...
PDF

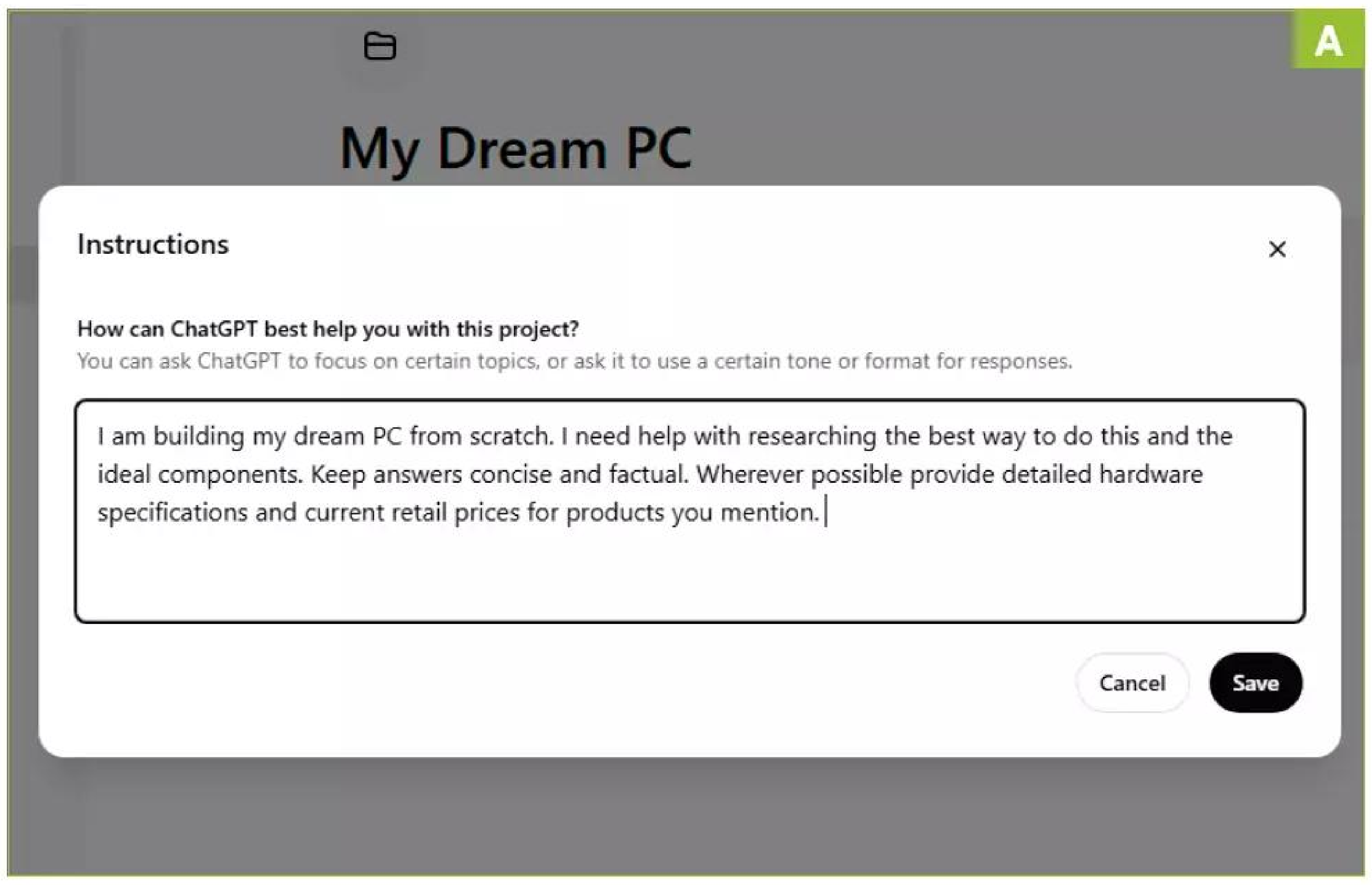
» You can do the same for any relevant files you have. Click 'Add Files' to upload from your local drive. ChatGPT supports most popular formats, including Microsoft Office documents, Markdown files, and PDFs. If you return to the main screen, the number of uploaded files are listed under 'Project files'. [**Image B**]

2 ADDING TO YOUR PROJECT

While Projects supports transferring chats and uploading existing content, you can also generate and store new conversations.

» In the previous step, we imported an existing chat about gaming monitors. To create another, just click 'New Chat in this project' and enter a new query, eg. "List the current top 3 gaming keyboards." [**Image C**]

» The new conversation will open in a separate tab. This is a good opportunity for you to check how faithfully ChatGPT has followed the instructions you set earlier. For instance, in the previous step we stated that

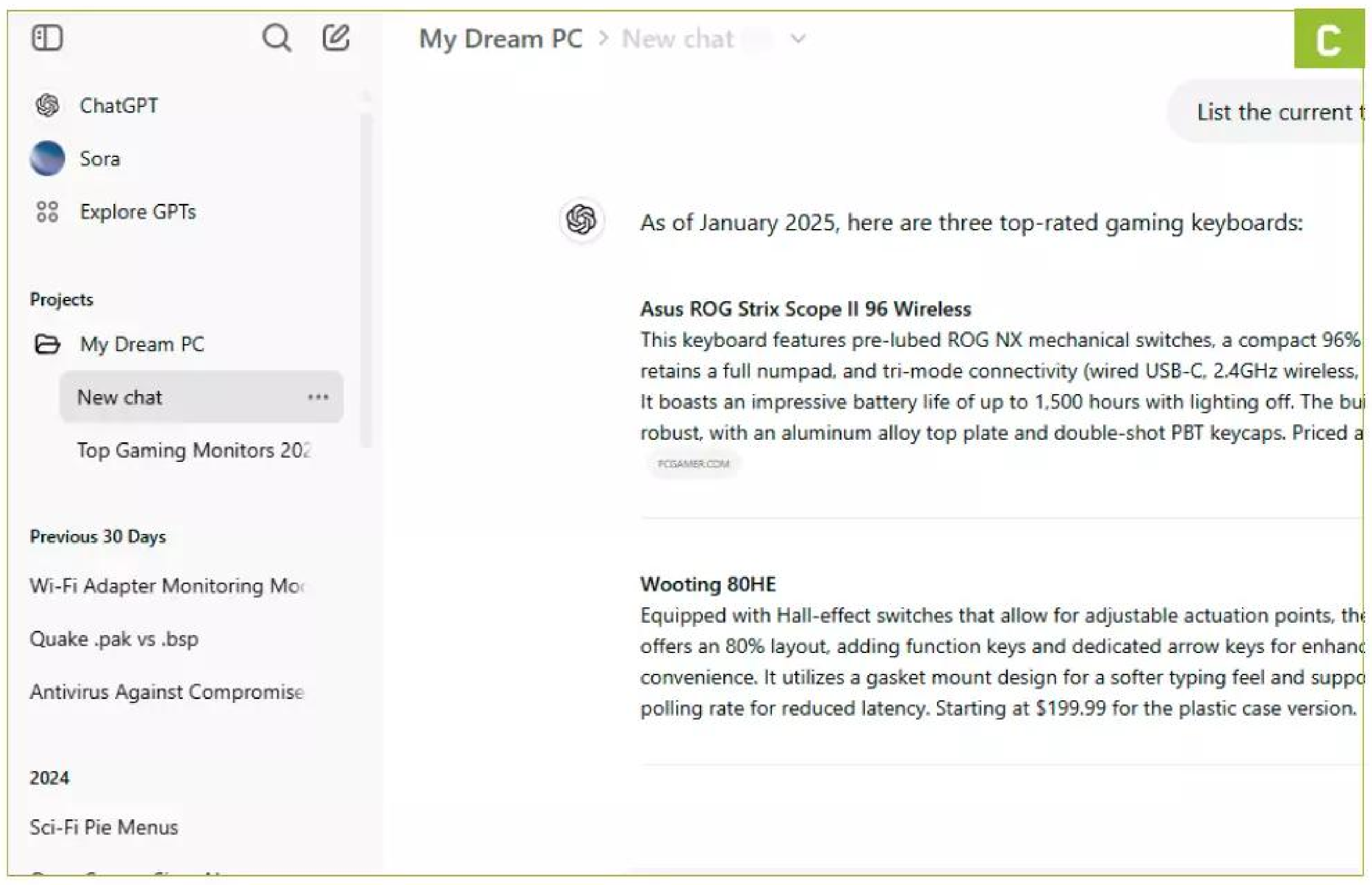


My Dream PC

Instructions

How can ChatGPT best help you with this project?
You can ask ChatGPT to focus on certain topics, or ask it to use a certain tone or format for responses.

I am building my dream PC from scratch. I need help with researching the best way to do this and the ideal components. Keep answers concise and factual. Wherever possible provide detailed hardware specifications and current retail prices for products you mention.

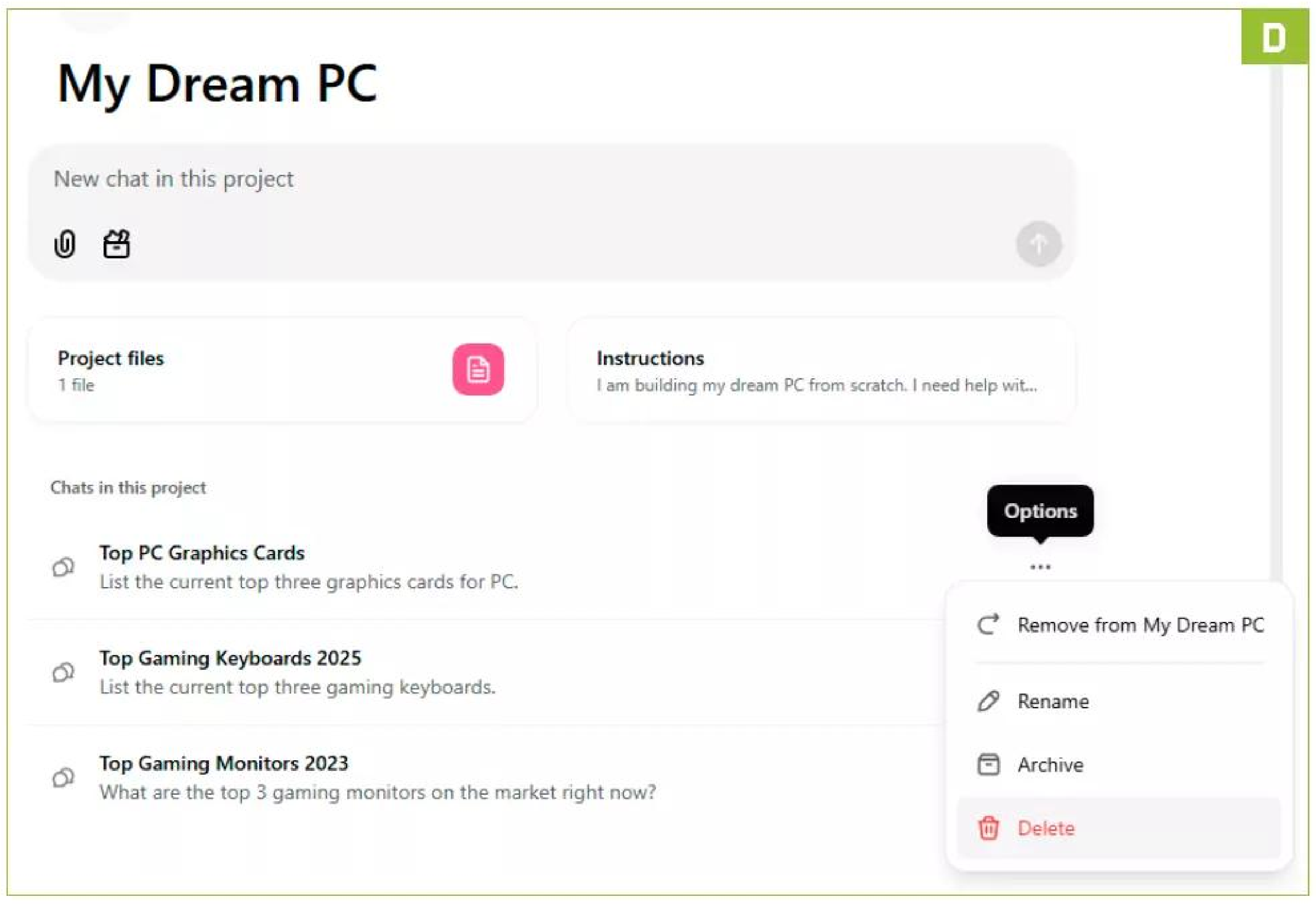


List the current

As of January 2025, here are three top-rated gaming keyboards:

Asus ROG Strix Scope II 96 Wireless
This keyboard features pre-lubed ROG NX mechanical switches, a compact 96%
retains a full numpad, and tri-mode connectivity (wired USB-C, 2.4GHz wireless,
It boasts an impressive battery life of up to 1,500 hours with lighting off. The bu
robust, with an aluminum alloy top plate and double-shot PBT keycaps. Priced a

Wooting 80HE
Equipped with Hall-effect switches that allow for adjustable actuation points, th
offers an 80% layout, adding function keys and dedicated arrow keys for enhanc
convenience. It utilizes a gasket mount design for a softer typing feel and suppo
polling rate for reduced latency. Starting at $199.99 for the plastic case version.


D
Options
Remove from My Dream PC
Rename
Archive
Delete

My Dream PC

New chat in this project

Project files
1 file

Instructions
I am building my dream PC from scratch. I need help wit...

Chats in this project

Top PC Graphics Cards
List the current top three graphics cards for PC.

Top Gaming Keyboards 2025
List the current top three gaming keyboards.

Top Gaming Monitors 2023
What are the top 3 gaming monitors on the market right now?

responses must be concise and list specifications and prices, which is the case here.

» Select your project name in the sidebar to return to the main window. From here, you can tweak instructions. We found this necessary, as by default, ChatGPT will list results based on your current location, as determined by your IP address. If your project is region-specific, be sure to specify your location.

» You can also add further conversations. These are listed under 'Chats in this project'. The options (...) button allows you to rename conversations for easy identification, as we had to amend the year to 2025 for the best gaming monitors. From here, you can also delete conversations you don't need. [**Image D**]

» Once you've put together information using multiple conversations and files, you can have your ChatGPT project collate this information. For example, there are two existing conversations concerning the three best current GPUs and three best gaming monitors on the market. We started a new conversation asking ChatGPT to determine the ideal combination of hardware components, based on the models it had already researched. ChatGPT listed this, along with a total price.

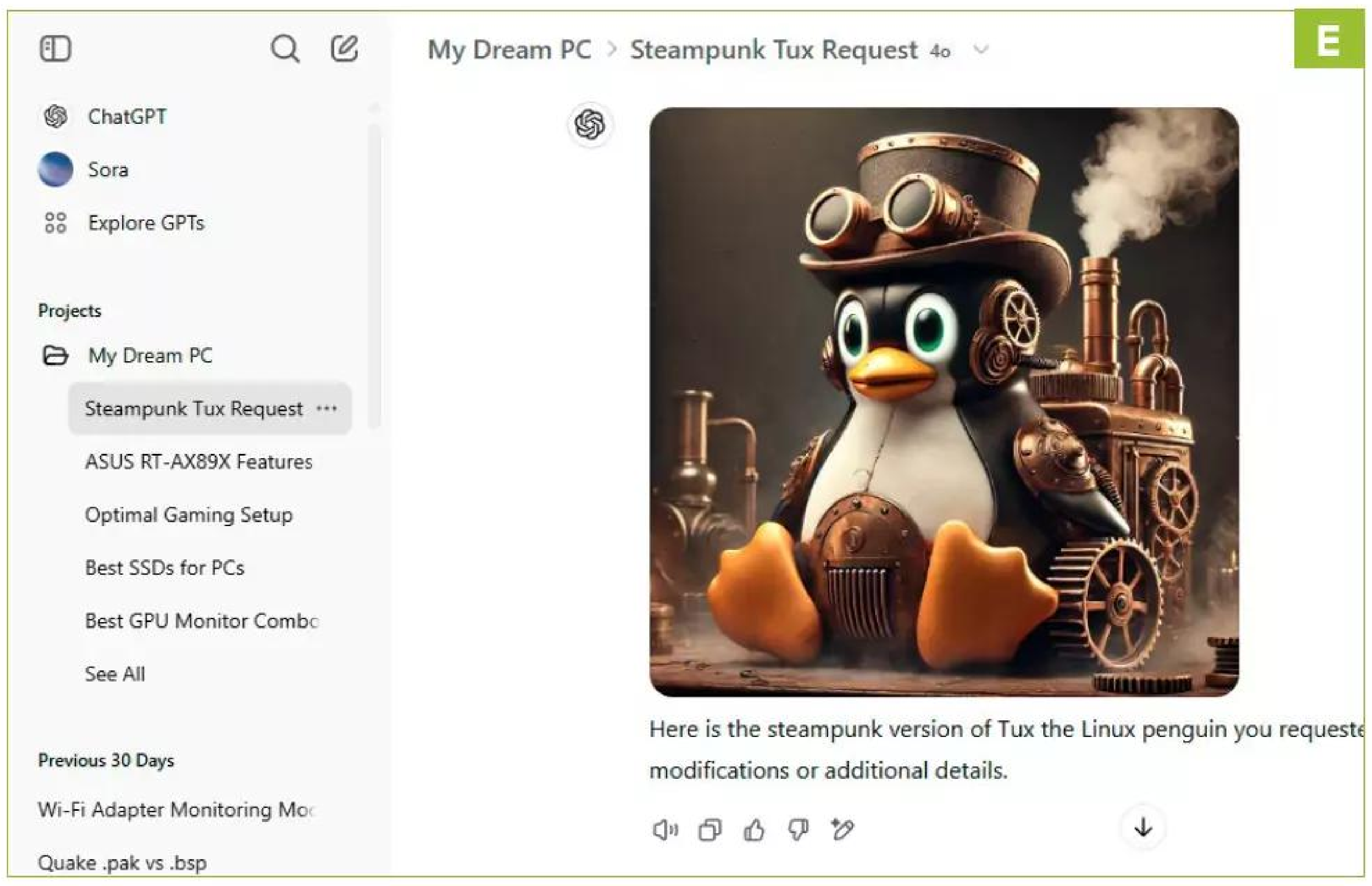
» ChatGPT defaults to the 4o model for projects. If you're preparing a project that doesn't require intensive processing, such as preparing a list of wedding guests you can switch to GPT-4o mini. This is usually much faster. To do this, select 'ChatGPT 4o' in the top-left, then 'More models' > 'GPT-4o mini'.

3

ADVANCED PROJECTS TOOLS

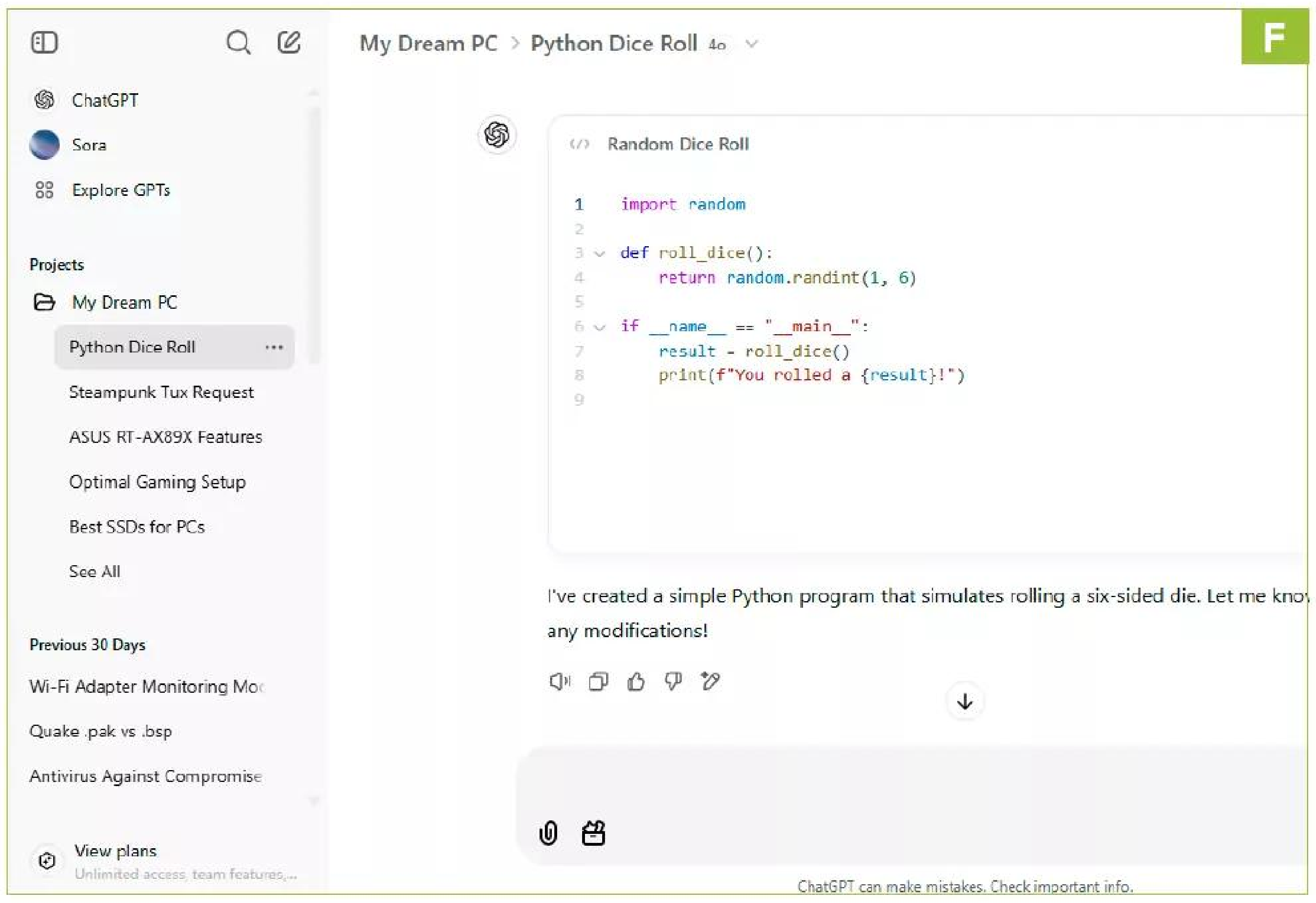
If you entered queries into the main projects window in the previous steps, you'll have noticed that there are options to both 'Attach files' and 'View tools'.

» The first option works in exactly the same way as ChatGPT, so you can upload a file for analysis. Projects also supports connecting Microsoft OneDrive or Google Drive accounts to upload files from there.


E
My Dream PC > Steampunk Tux Request 4o
ChatGPT
Sora
Explore GPTs
Projects
My Dream PC
Steampunk Tux Request
ASUS RT-AX89X Features
Optimal Gaming Setup
Best SSDs for PCs
Best GPU Monitor Combo
See All
Previous 30 Days
Wi-Fi Adapter Monitoring Mo
Quake .pak vs .bsp

Here is the steampunk version of Tux the Linux penguin you requeste
modifications or additional details.

© CHATGPT


F
My Dream PC > Python Dice Roll 4o
ChatGPT
Sora
Explore GPTs
Projects
My Dream PC
Python Dice Roll
Steampunk Tux Request
ASUS RT-AX89X Features
Optimal Gaming Setup
Best SSDs for PCs
See All
Previous 30 Days
Wi-Fi Adapter Monitoring Mo
Quake .pak vs .bsp
Antivirus Against Compromise
View plans
Unlimited access, team features,...
Random Dice Roll

```
import random

def roll_dice():
    return random.randint(1, 6)

if __name__ == "__main__":
    result - roll_dice()
    print(f"You rolled a {result}!")
```

I've created a simple Python program that simulates rolling a six-sided die. Let me kno
any modifications!

ChatGPT can make mistakes. Check important info.

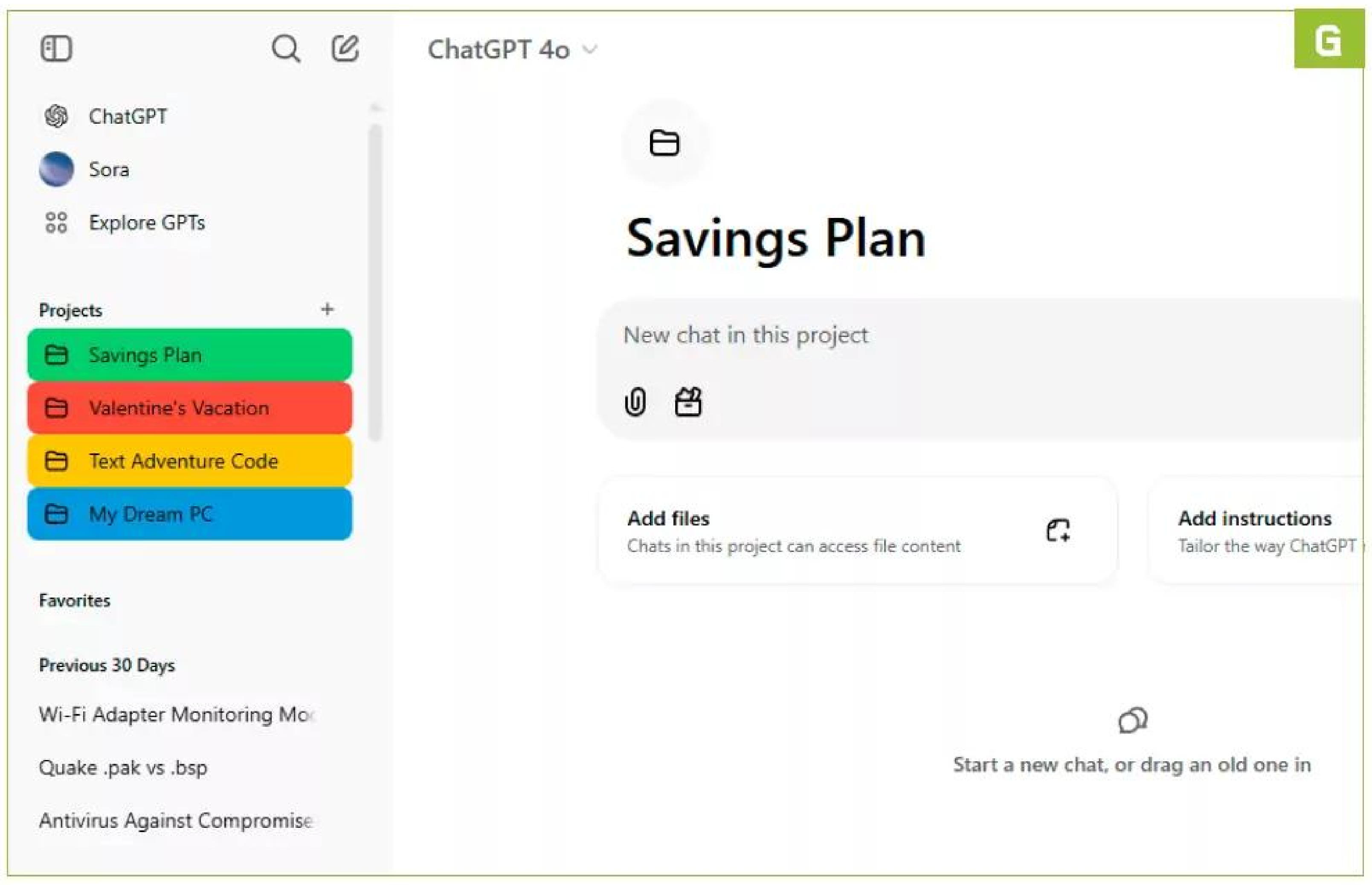
» During our tests, we found that files we attached to new chats in a project weren't automatically added to the 'Project files' section, even if we specifically requested that ChatGPT does so. This means if you want to analyze a file, you should add it to 'Project files' first, then create a new chat asking ChatGPT about it.

» You can also use the 'View tools' feature to access DALL-E. If you do this, the new chat prompt will read 'Picture', at which point you can enter your requirements. [**Image E**] As with any new chat, this will appear under 'Chats in this project' on the main window. You can also rename or delete it in the same way.

» 'View tools' can also access 'Canvas'. This is for collaborating on and writing code, though currently ChatGPT doesn't support multiple users accessing projects. However, you can prompt ChatGPT to write code relevant to your project. If you do so, this will open Canvas so you can review and comment. [**Image F**]

» In the first step, we also covered how to drag and drop a chat into a project window. This is useful if you only have one project, but inconvenient if you have multiple ones. Instead, click the (...) next to specific conversations, and hover over 'Add to Project'. From here you can choose a specific project.

» Currently, ChatGPT also has no built-in way to color-code projects. If you're using a Chromium-based browser like Chrome or Edge, you can fix this by installing the extension 'ChatGPT: Favorites & Color Highlighter for Projects & Chats'. Once you download it, click the (...) next to a project, then 'Color'. [**Image G**]


G
ChatGPT 4o
ChatGPT
Sora
Explore GPTs
Projects
Savings Plan
Valentine's Vacation
Text Adventure Code
My Dream PC
Favorites
Previous 30 Days
Wi-Fi Adapter Monitoring Mo
Quake .pak vs .bsp
Antivirus Against Compromise
Add files
Chats in this project can access file content
Add instructions
Tailor the way ChatGPT

Savings Plan

New chat in this project

Start a new chat, or drag an old one in

Tweak Windows 11's privacy settings

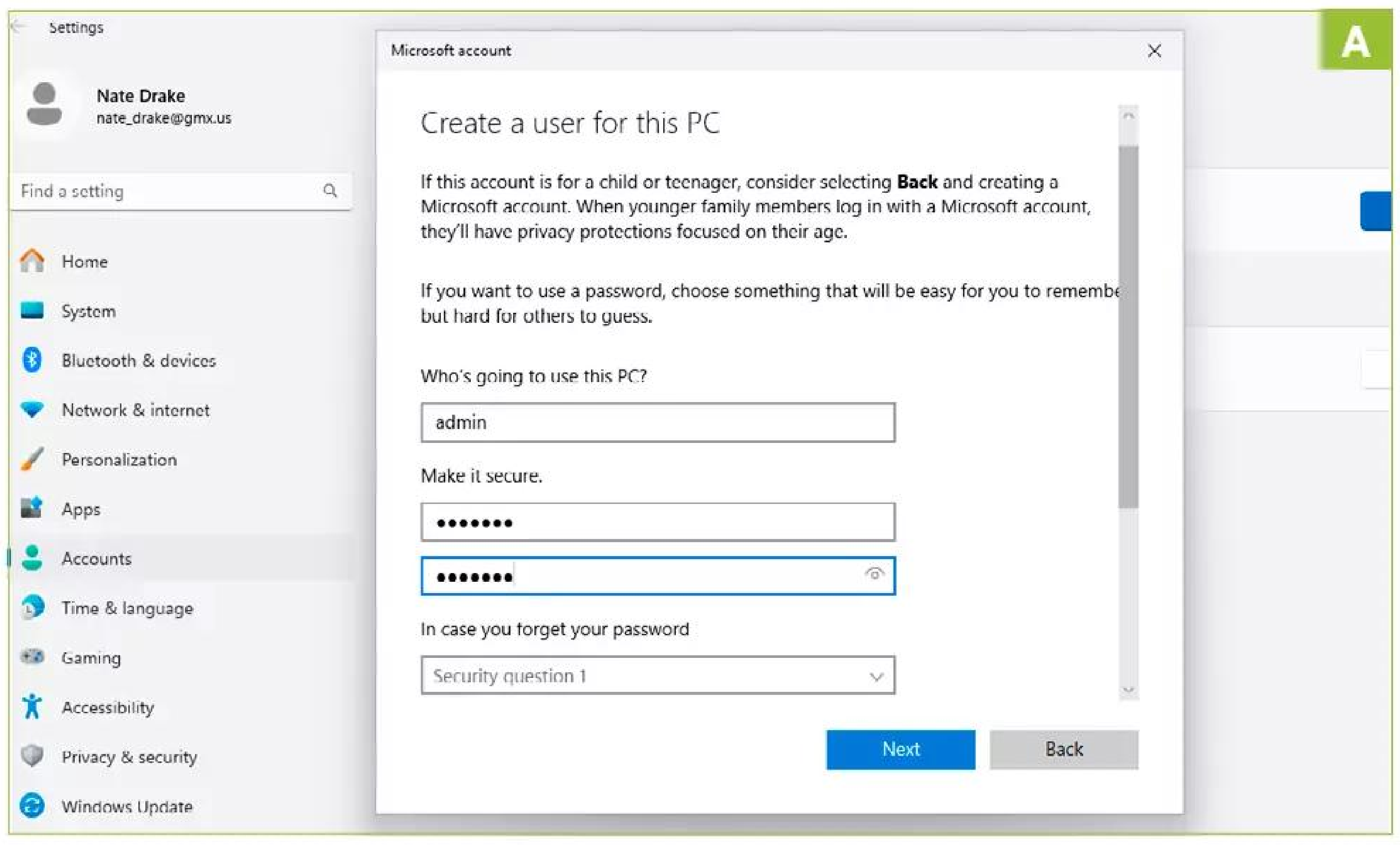
YOU'LL NEED THIS

WINDOWS 11
Notepad (included with Windows)

THE GNU WEBSITE, which is supported by the Free Software Foundation, contains a page entitled 'Microsoft's Software is Malware'. While this is an exaggeration, Windows 11 does raise some privacy concerns. For instance, the OS can display intrusive ads. It pressures users to run Microsoft apps like Edge, even when there are better alternatives. Windows also monitors user activity to suggest search results, and sends a great deal of 'diagnostic data' home to Microsoft.

While Windows 11 does have dedicated privacy settings, these are usually on an 'opt-out' basis. In this guide, we'll explore how to use Windows without an online Microsoft account. You'll also discover how to disable the most intrusive settings, as well as how to stop the OS from sending telemetry to Microsoft that could risk your privacy.

As this involves changing system settings, you should run a full backup of Windows 11 before continuing. **–NATE DRAKE**



Create a user for this PC

If this account is for a child or teenager, consider selecting **Back** and creating a Microsoft account. When younger family members log in with a Microsoft account, they'll have privacy protections focused on their age.

If you want to use a password, choose something that will be easy for you to remembe but hard for others to guess.

Who's going to use this PC?
admin

Make it secure.
•••••••
•••••••

In case you forget your password
Security question 1

1 REDUCE YOUR ATTACK SURFACE

One of the simplest ways to maximize your Windows 11 privacy is to do a clean install of the OS. During setup, you can choose to disable invasive settings like Location Services.

» Wiping the hard drive and reinstalling Windows 11 will also remove 'bloatware', which can slow down your machine and leak your personal data. Whether or not you reinstall Windows from scratch, on first login, type 'add' into the Windows search bar to launch 'Add/Remove Programs'. From here, you can uninstall any applications you don't use, such as the Xbox gaming bar or Clipchamp.

» Take a moment to enter 'Startup' to open 'Startup apps'. From here, you can disable any unnecessary programs, like Cortana. Remember: the fewer programs that are running, the less likely it is that your data will be exposed.

» Recent versions of Windows 11 have required users to sign in using an online Microsoft account. While this can be useful for syncing your preferences across devices, it means trusting your data to Microsoft.

» Go to 'Other users' in Windows' settings. From here, you can create a local admin account that's not registered on Microsoft's servers. Choose 'Add account' > "I don't have this person's sign-in information." > "Add a user without a Microsoft account". Here, you can enter a suitable username, eg. 'admin', password, and security questions for the local account. [**Image A**]

» Once the account has been created, click into it from Windows settings, and choose 'Change account type' to give it administrative privileges.

» Sign out of your Microsoft account and into the local account you just created. This will display a setup screen where you can choose privacy settings for this account.

» Make sure you disable 'Location'. 'Find my device' should be disabled by default. Ensure that 'Inking and typing' are also disabled, then choose 'Accept'.

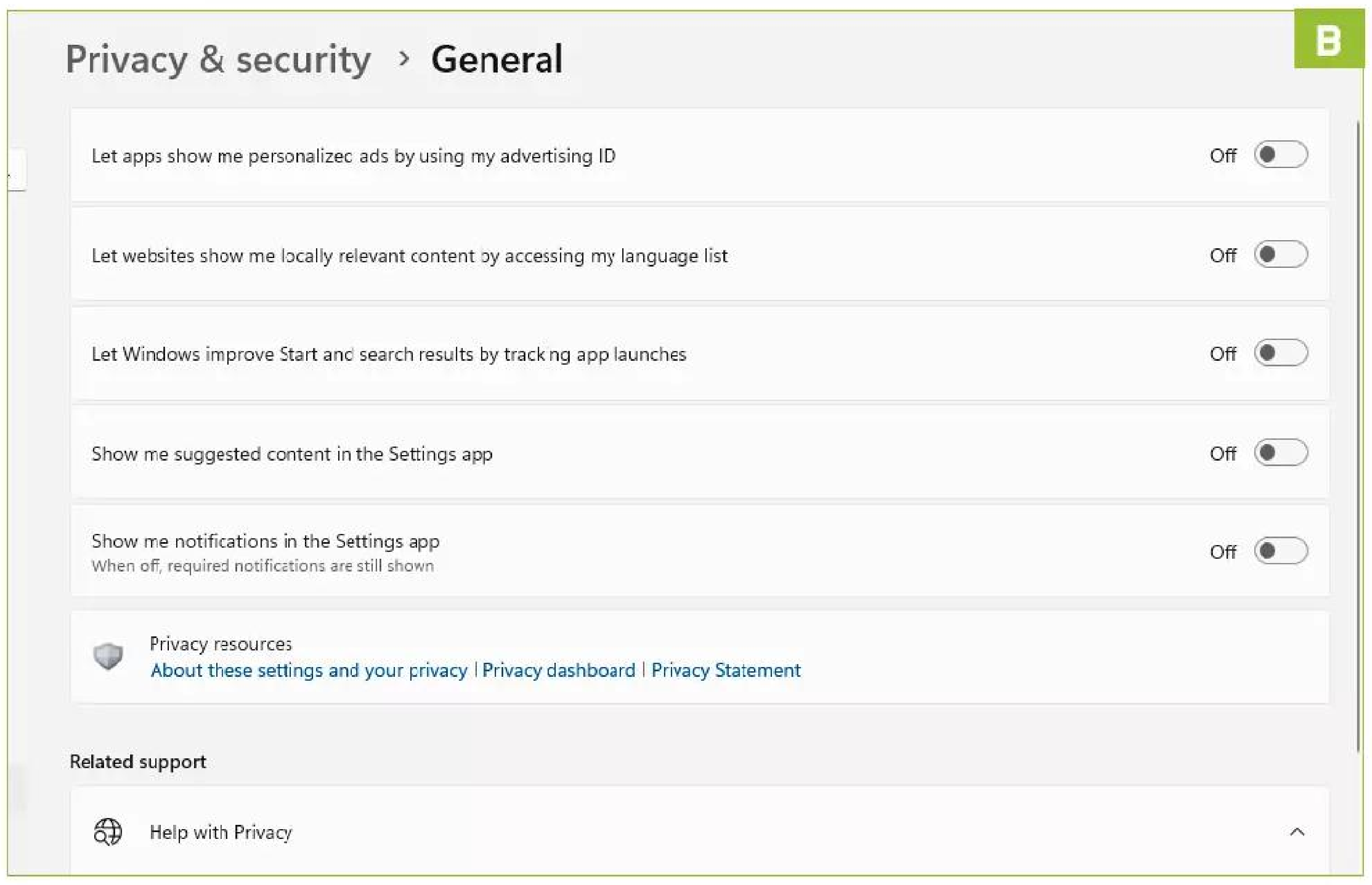
» Once the desktop loads, enter 'Privacy' into the search bar to launch 'Privacy settings'. Switch off all four of the enabled options here, such as letting Windows track app launches. [**Image B**]

2 SECURE YOUR CONNECTIONS

Disabling the options in Windows privacy settings will prevent you accidentally sharing most types of personal information with Microsoft.

» However, not all privacy-related settings are stored here. For example, use the search bar to open 'Notifications & actions', then expand the 'Additional settings' section. This contains options that govern suggestions on how to use Windows after an update or setup. However, in the nature of things, this means the system has to monitor your activity. Disable all three of these options. [**Image C**]

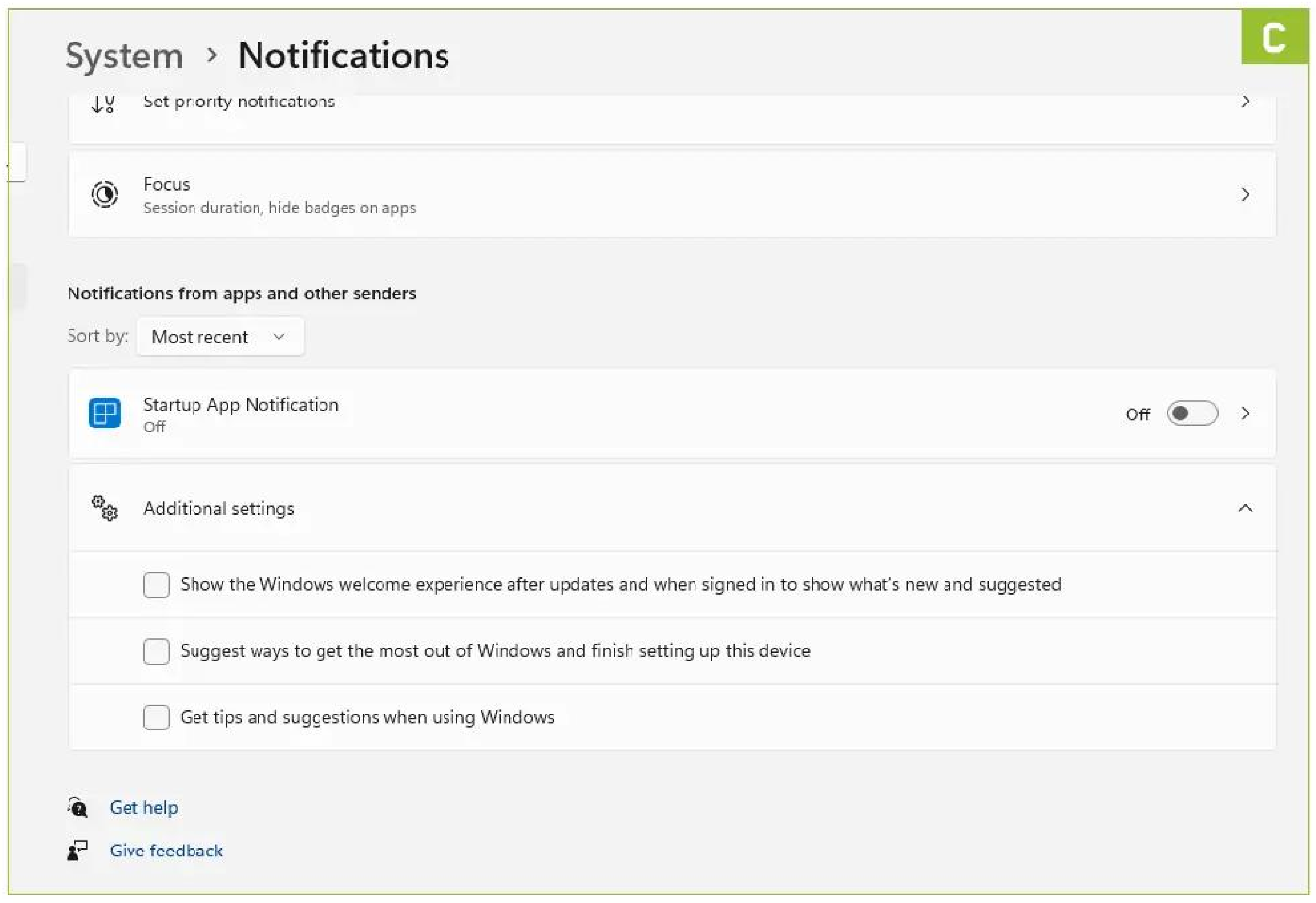
» Windows has built-in features that make it simple for others to connect to your device and share files. In the wrong hands, these could be used to introduce malicious payloads to your machine or steal sensitive files.



Let apps show me personalizec ads by using my advertising ID — Off
Let websites show me locally relevant content by accessing my language list — Off
Let Windows improve Start and search results by tracking app launches — Off
Show me suggested content in the Settings app — Off
Show me notifications in the Settings app — Off
When off, required notifications are still shown

Privacy resources
About these settings and your privacy | Privacy dashboard | Privacy Statement

© MICROSOFT



System › Notifications

Set priority notifications

Focus
Session duration, hide badges on apps

Notifications from apps and other senders

Sort by: Most recent

Startup App Notification
Off — Off

Additional settings

☐ Show the Windows welcome experience after updates and when signed in to show what's new and suggested

☐ Suggest ways to get the most out of Windows and finish setting up this device

☐ Get tips and suggestions when using Windows

» To prevent this, first open 'Nearby sharing settings', and ensure this is set to 'off'. If you're running Windows 11 Pro, you should also launch 'Remote desktop settings' to ensure this is also set to 'Off' until you need to use it. [**Image D**]

» Unless you're using 'Phone Link' to pair your computer with a mobile device, ensure that 'Phone Link' isn't running.

» Next, launch 'Autoplay' settings and change this to 'Off' for all media and devices. (You can still mount these manually via a suitable app like File Explorer).

» If you use the DNS servers provided by your ISP, your web activity is easier to monitor. The best solution is to use a reliable VPN provider to manage your DNS requests. This will encrypt the connection between your device and the VPN server, making it extremely difficult for bad actors to monitor your web usage.

» If this isn't feasible, switch to a more secure DNS provider. To do this, open 'Settings' > 'Network & internet', then 'Wi-Fi' or 'Ethernet'. From here, select 'Edit' by DNS server assignment and switch to 'Manual'. We recommend a privacy-focused provider like Cloudflare (1.1.1.1). Set DNS over HTTPS to 'On (automatic template) and 'Fallback to plaintext' to 'off'. [**Image E**]

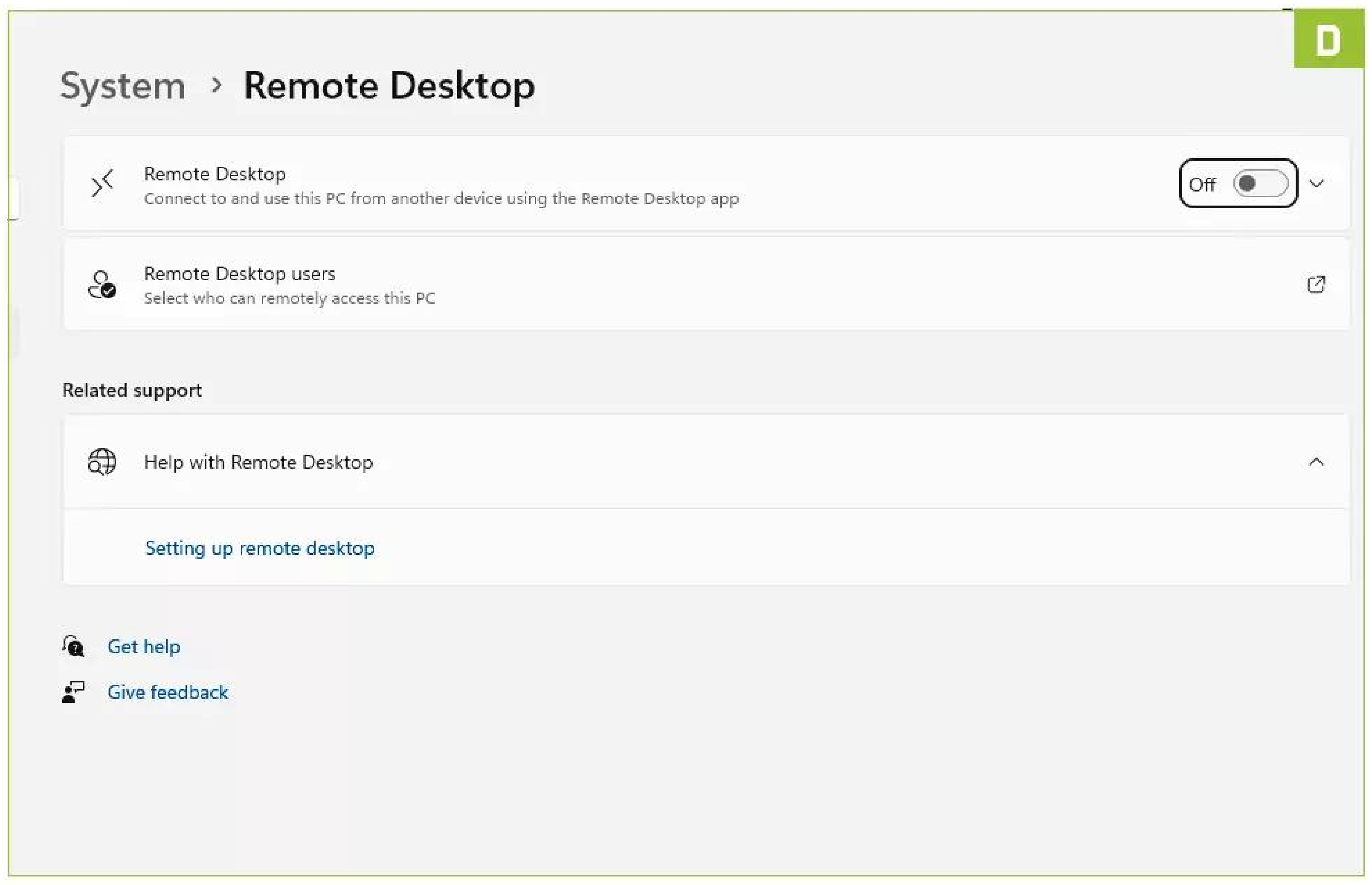
3

ADVANCED PRIVACY & SECURITY

Open 'Privacy & security' in Windows settings. First, go to 'Speech' and ensure that 'Online speech recognition' is disabled. Next, open 'Inking & typing personalization' to deactivate the custom dictionary.

» The options in the 'Diagnostics & feedback' section should be disabled, thanks to the steps you followed earlier. However, you can open this to 'Delete diagnostic data' that's been gathered.

» Next, visit the 'Activity history' section to set 'Store my activity on this device' to 'off'. Choose 'Clear history' while you're here to erase existing data.



System › Remote Desktop

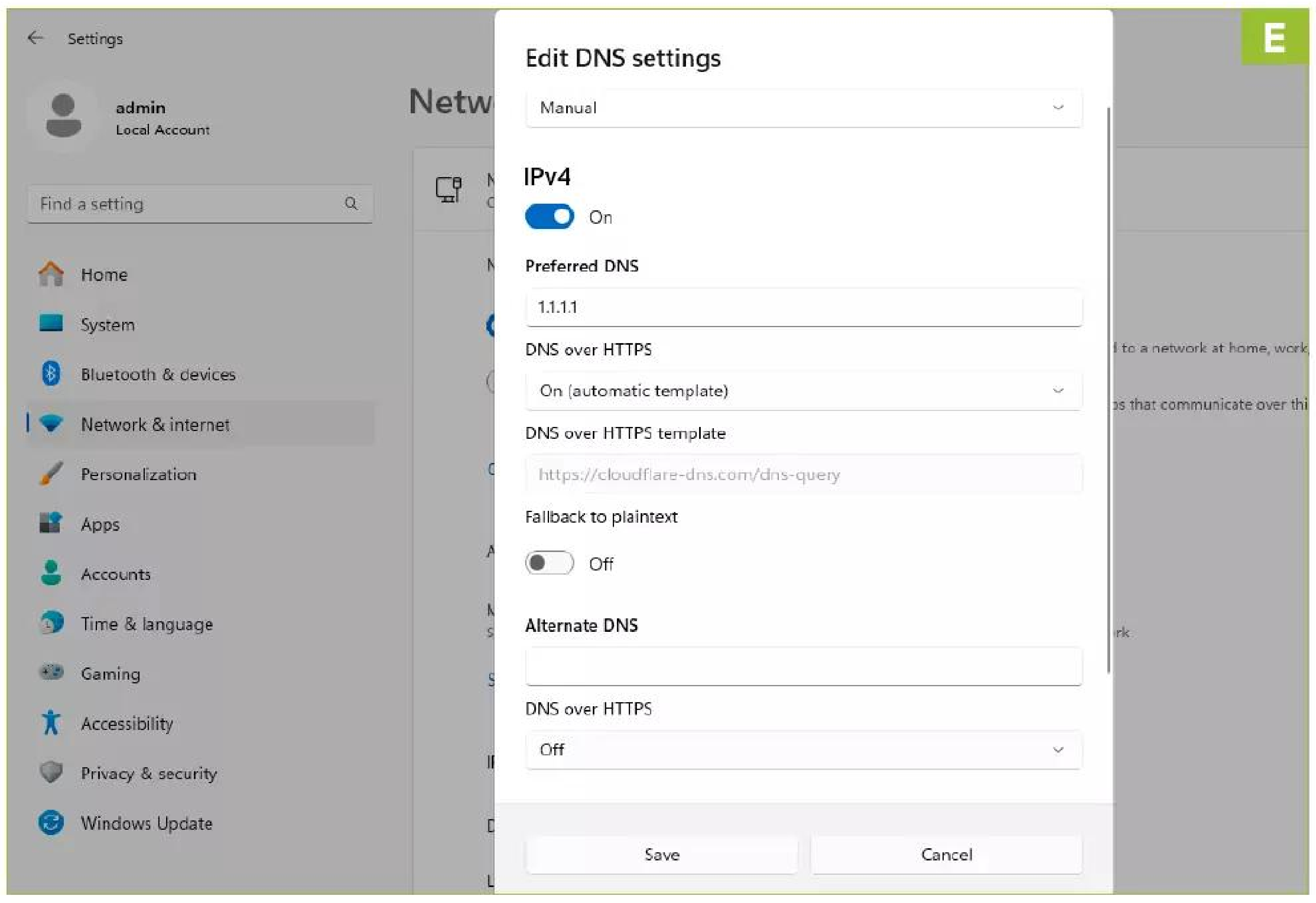
Remote Desktop
Connect to and use this PC from another device using the Remote Desktop app — Off

Remote Desktop users
Select who can remotely access this PC

Related support

Help with Remote Desktop

Setting up remote desktop



Edit DNS settings

Manual

IPv4
On

Preferred DNS
1.1.1.1

DNS over HTTPS
On (automatic template)

DNS over HTTPS template
https://cloudflare-dns.com/dns-query

Fallback to plaintext
Off

Alternate DNS

DNS over HTTPS
Off

» Open 'Search permissions' and scroll down to 'Cloud content search'. Disable this to prevent Windows from suggesting search results based on content in sources like your OneDrive folder. From here, you can disable the search history on your device, as well as search 'highlights'.

» If you scroll down to 'App permissions' in 'Privacy & security', you can also tweak settings for individual apps. For instance, opening 'Camera' lets you decide if apps can request access to it. You can also enable/disable the feature for specific programs. [**Image F**]

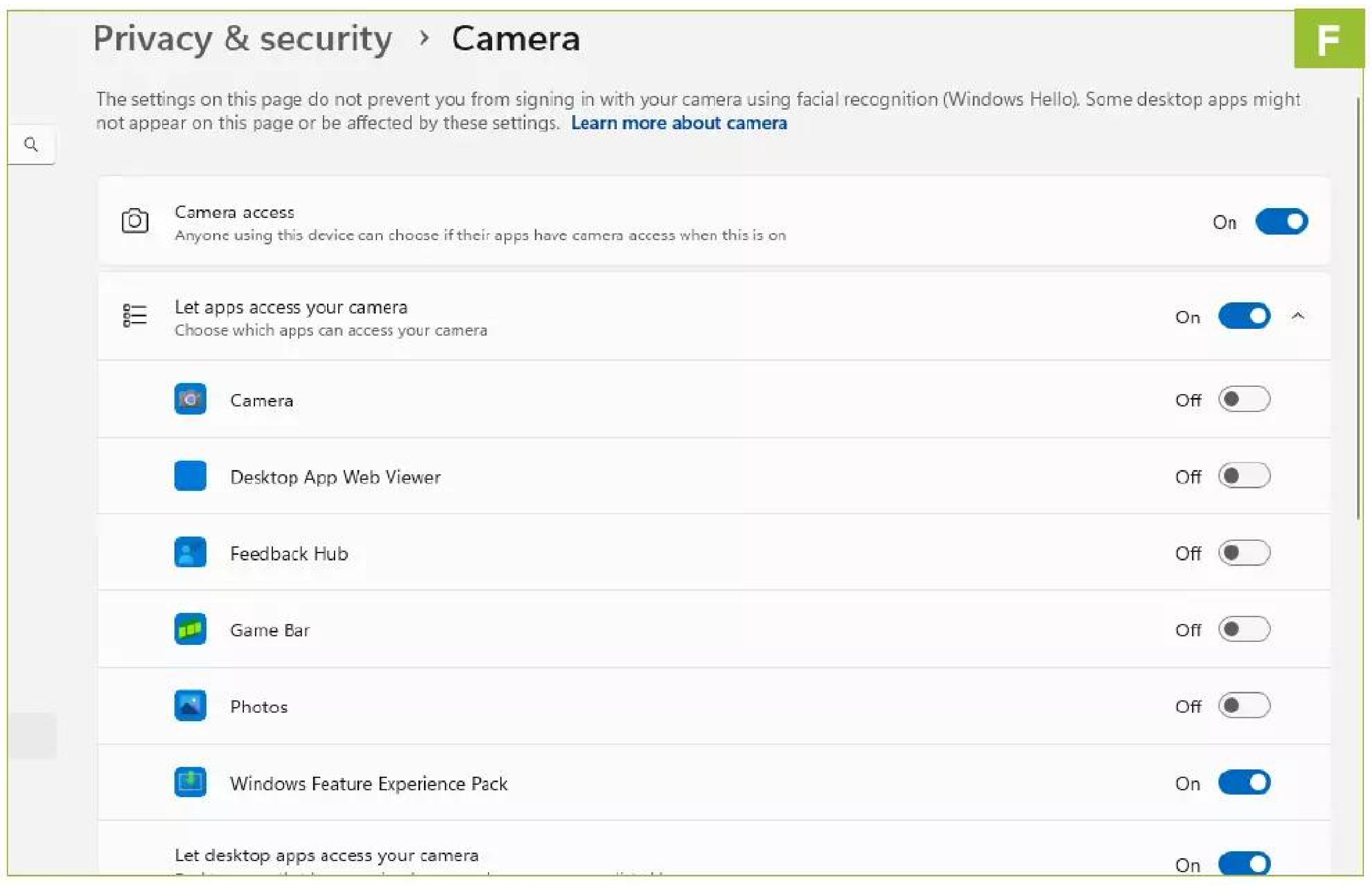
» By default, Windows 11's File Explorer displays notifications related to OneDrive and new Windows features. As this requires monitoring your activity, you should disable this feature, too. Click the ... inside any Explorer window, then 'Options'. Move to the 'View' tab, then uncheck 'Show sync provider notifications'.

» If you want to disable almost all Microsoft Telemetry, search for Powershell, then right-click to 'Run as Administrator.' Next, enter:

```
notepad C:\Windows\System32\drivers\etc\hosts
```

» Once Notepad opens, scroll to the bottom of the file. You can add DNS blocklists for domains that dial home to Microsoft Security expert maintains lists for these and other harmful domains. We recommend pasting in the list available from: bit.ly/hagezi-dns-block-list.

» This list is constantly updated, so you should check it regularly to ensure that you're blocking all forms of Windows and Microsoft Office telemetry. This may also cause issues loading legitimate Microsoft pages and documents, so save a copy of the original 'host' file first. ⏻



Privacy & security › Camera

The settings on this page do not prevent you from signing in with your camera using facial recognition (Windows Hello). Some desktop apps might not appear on this page or be affected by these settings. Learn more about camera

Camera access
Anyone using this device can choose if their apps have camera access when this is on — On

Let apps access your camera
Choose which apps can access your camera — On

Camera — Off
Desktop App Web Viewer — Off
Feedback Hub — Off
Game Bar — Off
Photos — Off
Windows Feature Experience Pack — On

Let desktop apps access your camera — On

Spot phishing emails

YOU'LL NEED THIS

UBLOCK ORIGIN
(optional)

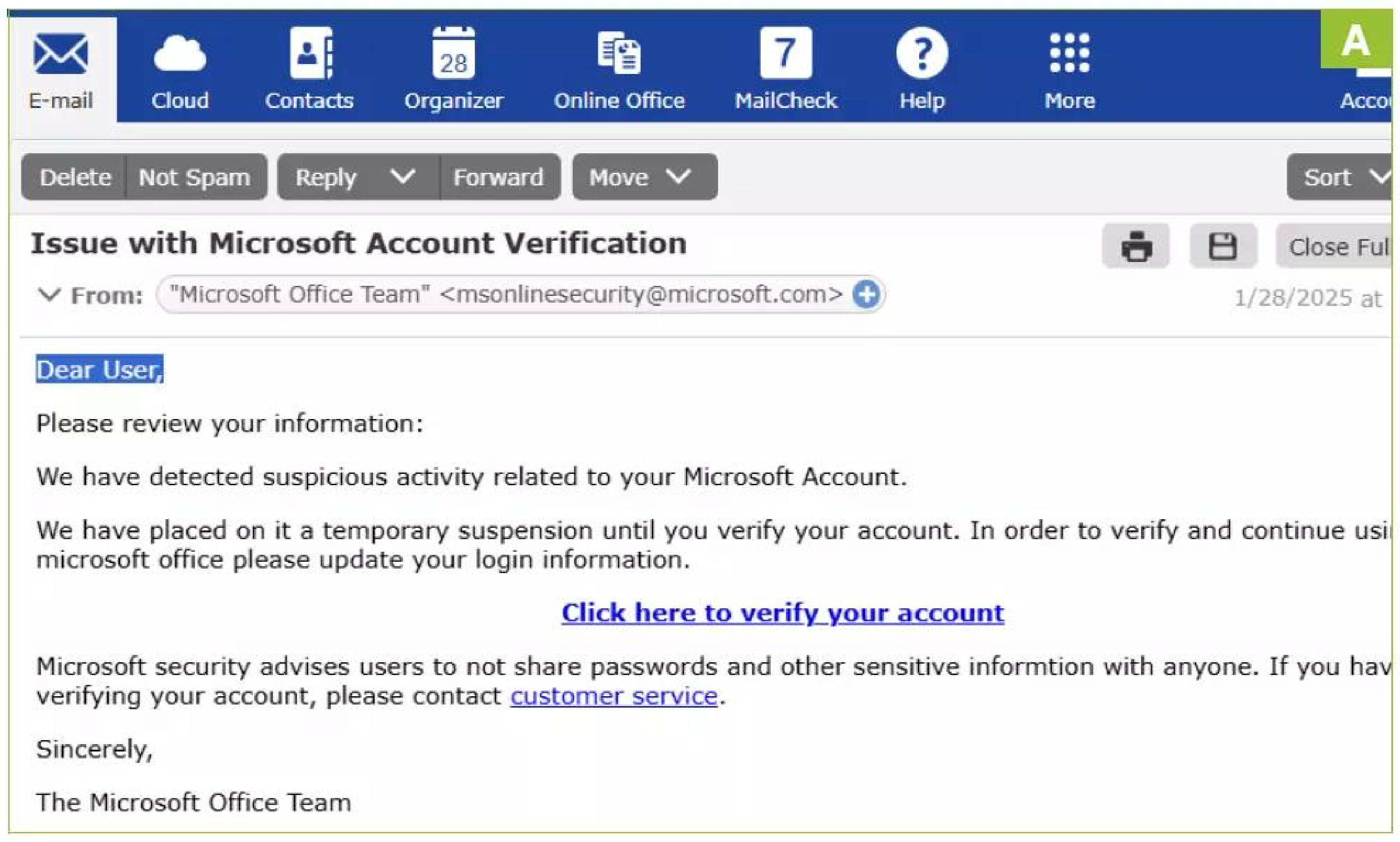
ACCORDING TO NETWORK SECURITY company SlashNext's 2024 Phishing Intelligence Report, in the second half of 2024, there was a 202 percent overall rise in phishing messages.

One of the most common attack vectors is email. Often, this takes the form of legitimate-looking messages. Recipients are encouraged to click a link or open an attachment. Sometimes, the aim is simply to steal personal information like credit card details.

The best way to stay safe is never to believe anything you read in an email or open any links/files in your inbox. However, this isn't very practical in 2025, as many legitimate organizations communicate with customers in this way.

This guide focuses on how to analyze emails to find telltale signs of phishing activity.

–NATE DRAKE



Issue with Microsoft Account Verification

From: "Microsoft Office Team" <msonlinesecurity@microsoft.com>

1/28/2025 at

Dear User,

Please review your information:

We have detected suspicious activity related to your Microsoft Account.

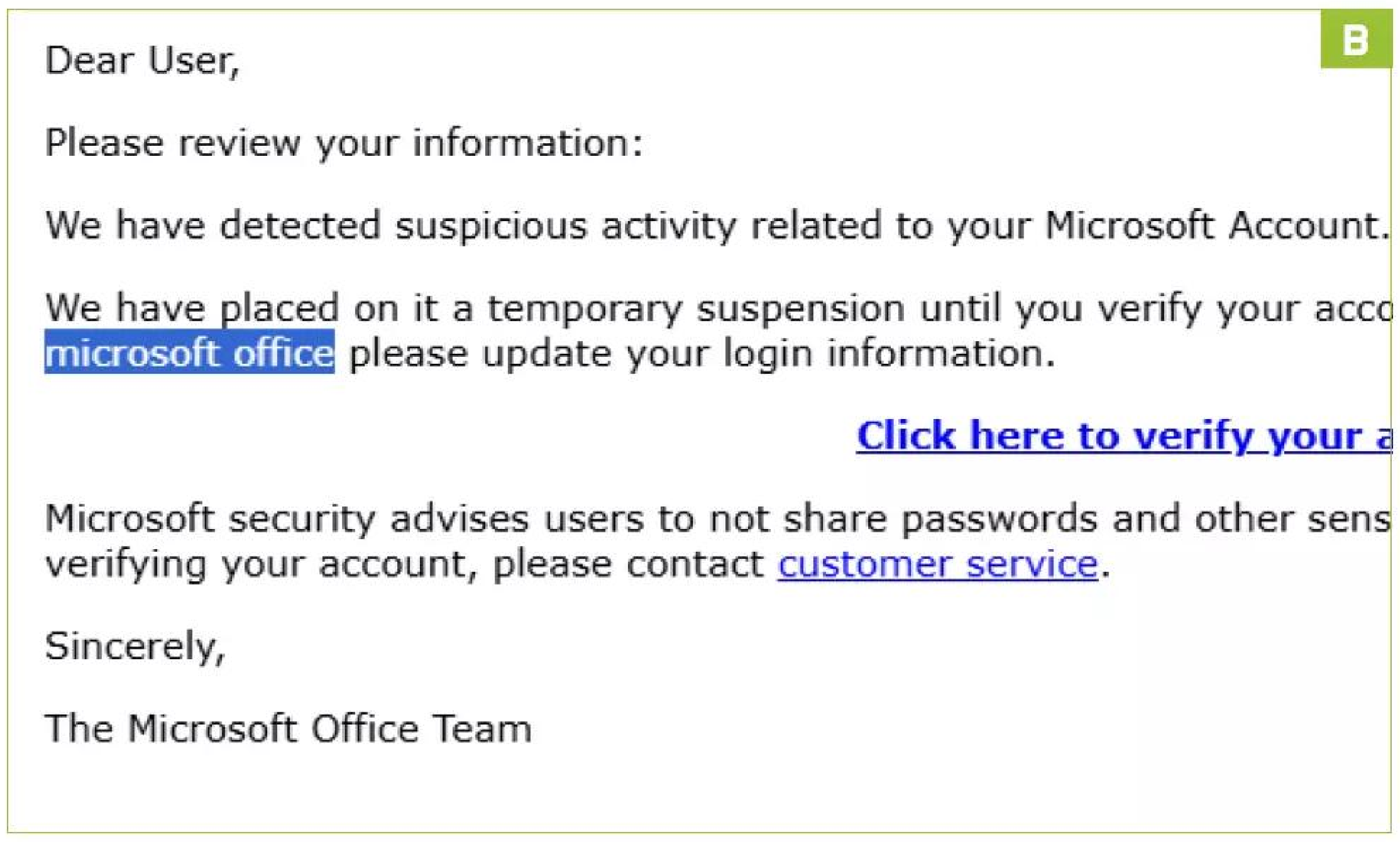
We have placed on it a temporary suspension until you verify your account. In order to verify and continue usi
microsoft office please update your login information.

Click here to verify your account

Microsoft security advises users to not share passwords and other sensitive informtion with anyone. If you hav
verifying your account, please contact customer service.

Sincerely,

The Microsoft Office Team



Dear User,

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microsoft office please update your login information.

Click here to verify your a

Microsoft security advises users to not share passwords and other sens
verifying your account, please contact customer service.

Sincerely,

The Microsoft Office Team

1 APPLY OCCAM'S RAZOR

While some phishing emails are carefully crafted and targeted at individuals in 'spear phishing' attacks, most of them use boilerplate wording to try to fool people en masse.

» This is why if you're trying to verify if an email is legitimate, you should always] check that it greets you by name. If a message begins with 'Dear Customer' or 'Dear User', this is an automatic red flag. [**Image A**]

» Unfortunately, you can't always establish an email's bona fides by checking the 'From' address, as the Simple Mail Transfer Protocol (SMTP) has no built-in authentication mechanism, making it easy to impersonate someone else.

» However, you can check if the 'from' address matches previous emails that you've received from the same person or organization.

» Another clear indicator of a phishing email is that it encourages you to hand over sensitive information. Again, this is a question of applying common sense. For instance, your bank would never ask for your credit card details, as they already have this information on file.

» If the email purports to be from a person or organization based in an English-speaking country like the USA, you should also check the spelling and grammar carefully.

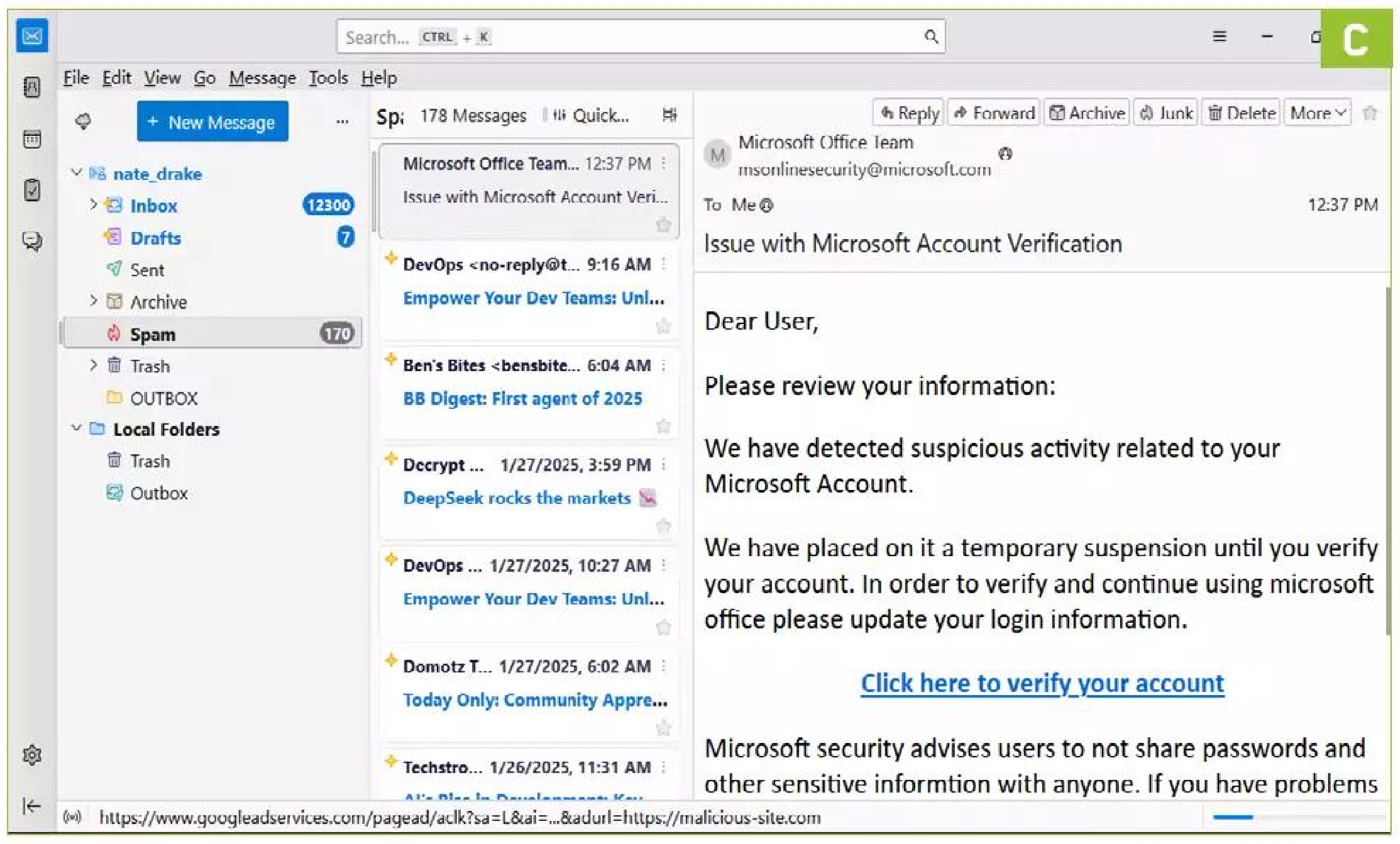
» These days, scammers use AI to polish their messages. However, you may pick up on subtle misspellings or turns of phrase. For instance, in the example listed here, 'Microsoft Office' (a proper noun), is written in lower case. [**Image B**]

» Phishing emails are also designed to create a sense of urgency in the hope that the reader will let their panic override their common sense. Themes include a fake alert that your account has been compromised, so you have to act quickly to reset your password. Sometimes, the message will appear to be from a legitimate courier company saying that you need to pay an outstanding fee.

» If you do need to verify your payment information or pay a fee, use a search engine to find the legitimate domain or telephone number to contact your provider.

2 VERIFY LINKS AND ATTACHMENTS

If a suspicious email contains a link, it stands to reason that you shouldn't click on it. However, you can often double check if a URL is legitimate by hovering over it. This isn't always as easy as it sounds.



Microsoft Office Team... 12:37 PM
Issue with Microsoft Account Veri...

DevOps <no-reply@t... 9:16 AM
Empower Your Dev Teams: Unl...

Ben's Bites <bensbite... 6:04 AM
BB Digest: First agent of 2025

Decrypt ... 1/27/2025, 3:59 PM
DeepSeek rocks the markets

DevOps ... 1/27/2025, 10:27 AM
Empower Your Dev Teams: Unl...

Domotz T... 1/27/2025, 6:02 AM
Today Only: Community Appre...

Techstro... 1/26/2025, 11:31 AM

Microsoft Office Team
msonlinesecurity@microsoft.com

To Me

12:37 PM

Issue with Microsoft Account Verification

Dear User,

Please review your information:

We have detected suspicious activity related to your Microsoft Account.

We have placed on it a temporary suspension until you verify your account. In order to verify and continue using microsoft office please update your login information.

Click here to verify your account

Microsoft security advises users to not share passwords and other sensitive informtion with anyone. If you have problems

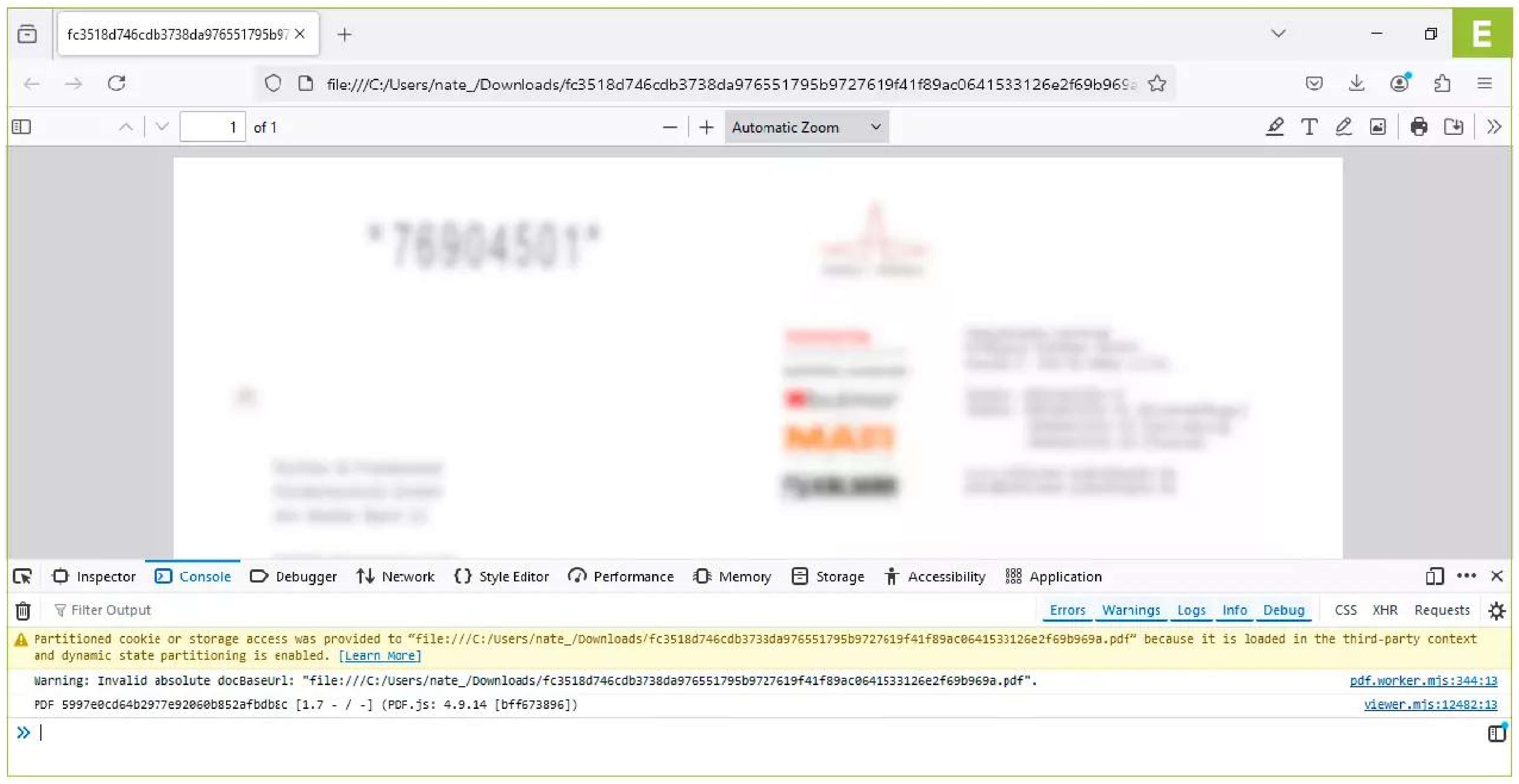
https://www.googleadservices.com/pagead/aclk?sa=L&ai=...&adurl=https://malicious-site.com

© UBLOCK ORIGIN

» Take, for instance, this link we received from N26, encouraging us to download the latest version of the bank's app: https://app.adjust.com/q5u9oj_vvsbsn?deep_link=number26%3A%2F%2F&ampfallback=https%3A%2F%2Fsupport.n26.com%2Fen-eu%2Fgetting-started%2Faccount.

» In this case, the first part of the URL relates to 'Adjust'—a third-party analytics and tracking platform. This is no doubt designed to help the bank understand how users interact with their campaigns.

» The 'deep link' is designed to open the URL in the app itself where available, while the 'fallback' section has a link with instructions on how to download it if the 'deep link' fails.



fc3518d746cdb3738da976551795b97

file:///C:/Users/nate_/Downloads/fc3518d746cdb3738da976551795b9727619f41f89ac0641533126e2f69b969a

1 of 1 Automatic Zoom

```
Partitioned cookie or storage access was provided to "file:///C:/Users/nate_/Downloads/fc3518d746cdb3733da976551795b9727619f41f89ac0641533126e2f69b969a.pdf" because it is loaded in the third-party context and dynamic state partitioning is enabled. [Learn More]
Warning: Invalid absolute docBaseUrl: "file:///C:/Users/nate_/Downloads/fc3518d746cdb3738da976551795b9727619f41f89ac0641533126e2f69b969a.pdf".    pdf.worker.mjs:344:13
PDF 5997e0cd64b2977e92060b852afbdb8c [1.7 - / -] (PDF.js: 4.9.14 [bff673896])    viewer.mjs:12482:13
```

» Phishing emails are not usually as sophisticated, but may make use of trusted domains to redirect users to a malicious URL, eg: www.googleadservices.com/pagead/aclk?sa=L&ai=...&adurl=https://malicious-site.com.

» This complex URL structure makes [**Image C**] it difficult for users to determine the ultimate destination of links. Of course, you can sidestep this problem by logging into your online account in a new browser tab instead of launching URLs in emails.

» If you're worried about accidental clicks, the uBlock Origin browser extension's 'badware risks' feature can filter out malicious domains. These are community-maintained lists that block potentially harmful URLs.

» Due to Google's adoption of Manifest v3, ad blockers are now much less efficient in Chromium-based browsers like Chrome and Edge. Use an open-source browser instead, like Mozilla Firefox. [**Image D**]

» Most modern email servers automatically screen messages with suspicious attachments, such as .exe and .jar. Some scammers have adapted to this by hiding malicious payloads inside PDFs. If you have to open these, do so in your browser, as the PDF viewer is usually sandboxed. We did this in Firefox with an infected PDF sample from our friends at the Malware Bazaar, with no ill effects for our virtual machine. [**Image E**]

3

CHECK DMARC AND SPF

While SMTP itself has no built-in way to authenticate senders, there are two key technologies that can be used to verify that an email is legitimate.

» The first of these is Sender Policy Framework (SPF). This is a DNS (Domain Name System) record that specifies the IP addresses of any mail servers that are authorized to send emails on behalf of a given domain.

» When an email is sent, the receiving mail server can check the SPF record to confirm if the sending server is listed as legitimate. Some domains may allow messages that fail SPF checks to be delivered, but marked with warnings. This can mean the message will be sent to a Junk/Spam folder, depending on the receiving mail server's policies.

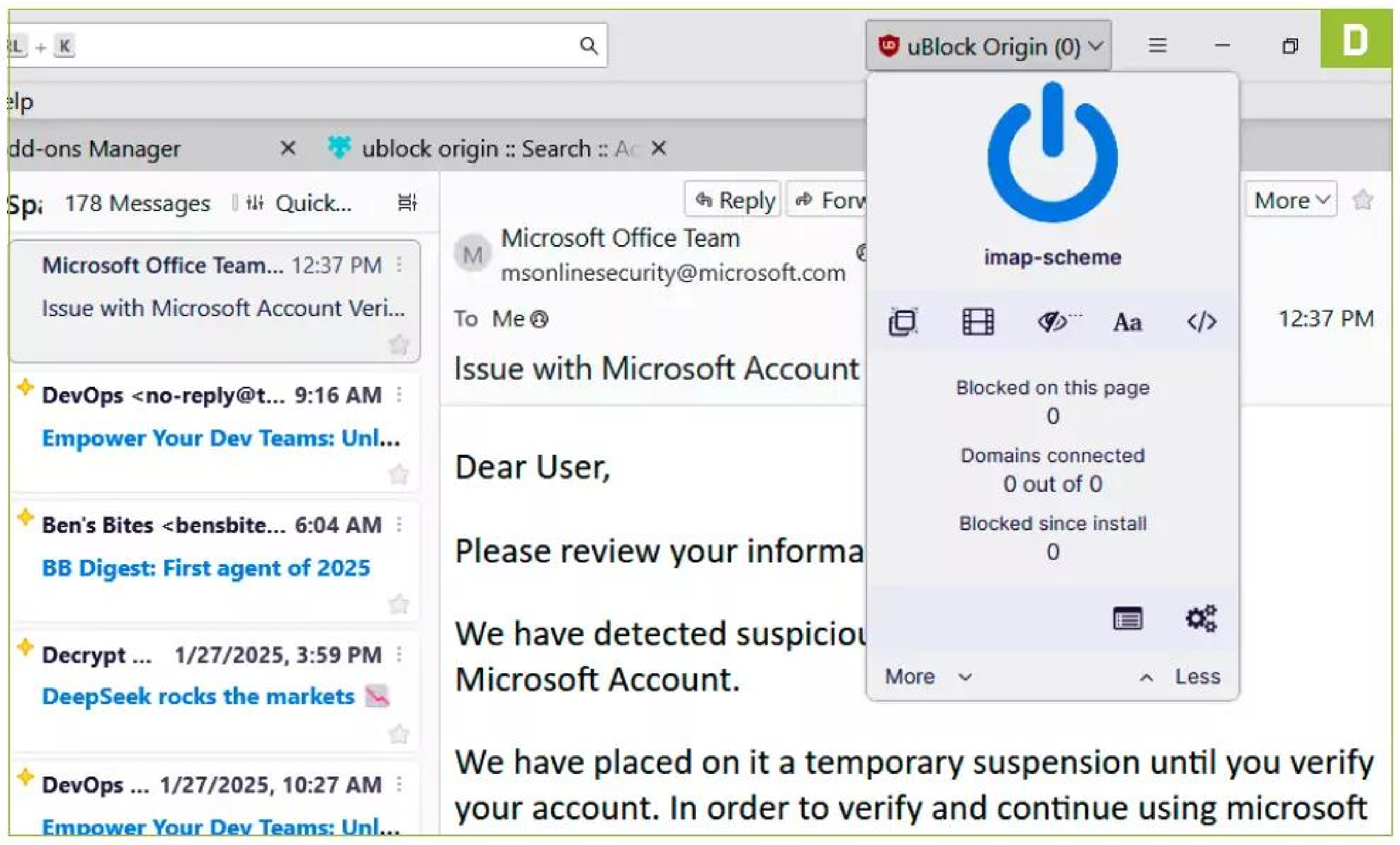
» DMARC builds on SPF and DKIM (DomainKeys Identified Mail) to provide even stronger protection against spoofed email addresses. It provides more scope to allow domain providers to publish policies in their DNS records on how to handle emails that fail authentication checks. For instance, it supports reporting so providers can detect phishing activity. DMARC also ensures that the 'From' address seen by the recipient matches the domain authenticated via SPF or DKIM.

» You can find information on both SPF and DMARC checks in your email headers. The way you access these will vary depending on your chosen email software. For example, to view message headers when checking your emails on gmail.com, click the options (...) button, then 'Show original'. [**Image F**]

» Scroll down to the 'Authentication-Results' section to see more. If the SPF requirements have been met you'll see a line starting 'spf=pass'. This is usually followed by the IP address of the mail server and the web domain in question.

» You should also find a line beginning 'dmarc=pass'. This will be followed by the 'header.from' address to indicate that the 'From' email address matches that of the mail server that sent the original message.

» Remember, these checks only ensure that the email address comes from a legitimate server. If the sender's account has been compromised, the email will still appear to be valid.



178 Messages | Quick...

Microsoft Office Team... 12:37 PM
Issue with Microsoft Account Veri...

DevOps <no-reply@t... 9:16 AM
Empower Your Dev Teams: Unl...

Ben's Bites <bensbite... 6:04 AM
BB Digest: First agent of 2025

Decrypt ... 1/27/2025, 3:59 PM
DeepSeek rocks the markets

DevOps ... 1/27/2025, 10:27 AM
Empower Your Dev Teams: Unl...

Microsoft Office Team
msonlinesecurity@microsoft.com
To Me
12:37 PM
Issue with Microsoft Account

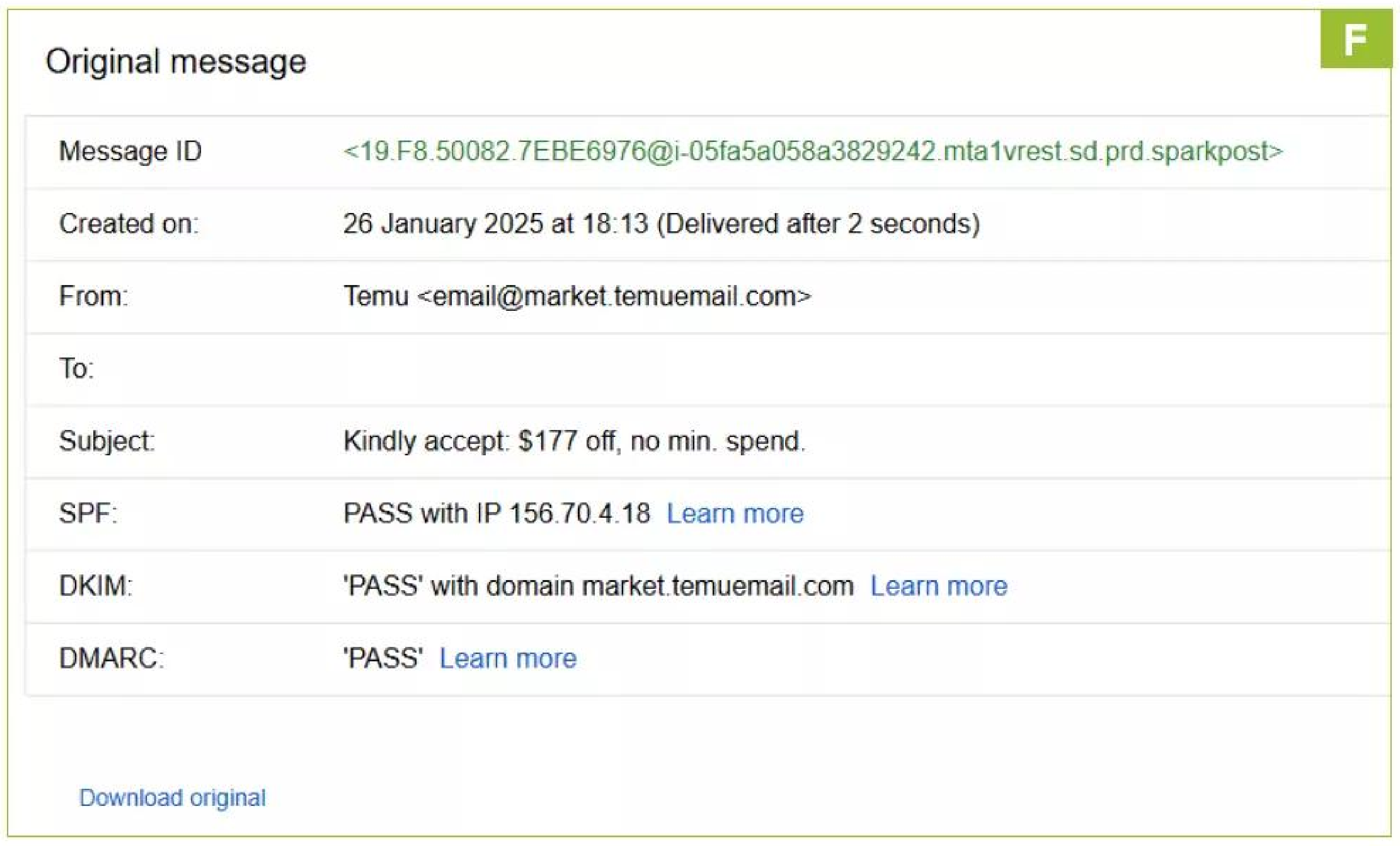
Dear User,

Please review your informa

We have detected suspiciou
Microsoft Account.

We have placed on it a temporary suspension until you verify your account. In order to verify and continue using microsoft

Blocked on this page
0
Domains connected
0 out of 0
Blocked since install
0



Original message

Message ID	<19.F8.50082.7EBE6976@i-05fa5a058a3829242.mta1vrest.sd.prd.sparkpost>
Created on:	26 January 2025 at 18:13 (Delivered after 2 seconds)
From:	Temu <email@market.temuemail.com>
To:	
Subject:	Kindly accept: $177 off, no min. spend.
SPF:	PASS with IP 156.70.4.18 Learn more
DKIM:	'PASS' with domain market.temuemail.com Learn more
DMARC:	'PASS' Learn more

Download original

Play Arcade Classic with MAME

YOU'LL NEED THIS

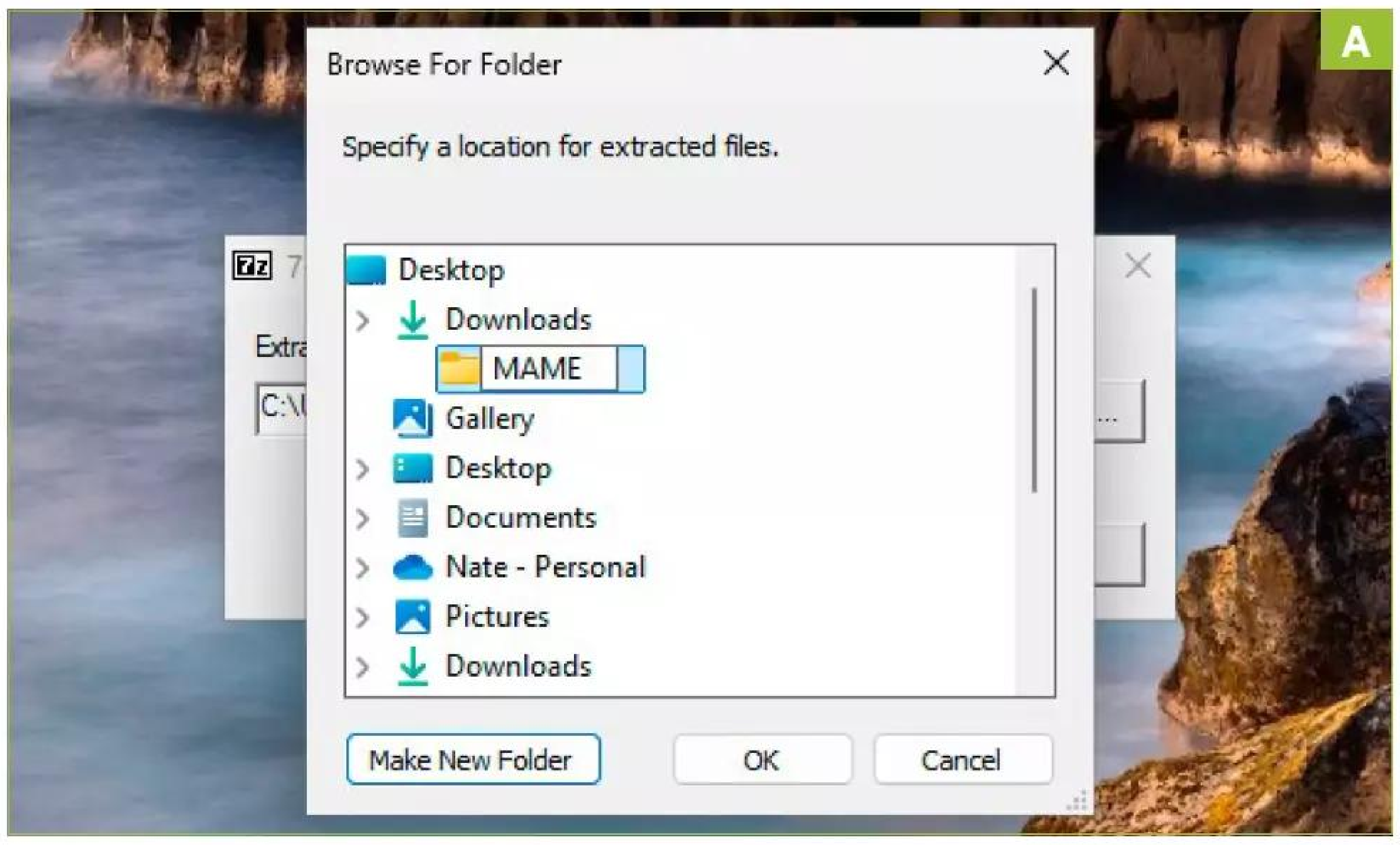
MAME
www.mamedev.org/release.html

WHILE MANY READERS may have fond memories of plowing loose change into arcade machines as children, games are usually enjoyed from our living rooms these days.

However, many arcade titles didn't make it to home consoles. Those that did sometimes lost some of their charm. For instance, the SNES conversion of *Street Fighter II* had radically altered backgrounds, and even censored more violent aspects of gameplay.

MAME (formerly an acronym of 'Multiple Arcade Machine Emulator') is designed to address this. Since 1997, this open-source software has been designed to recreate the hardware of retro arcade machines, videogame consoles, and older PCs. The project website makes MAME available free of charge, along with some 'ROMS' for personal use.

In this guide, you'll discover how to set up MAME, as well as how to tweak the monitor and controller settings for an authentic vintage gaming experience. –**NATE DRAKE**



Browse For Folder

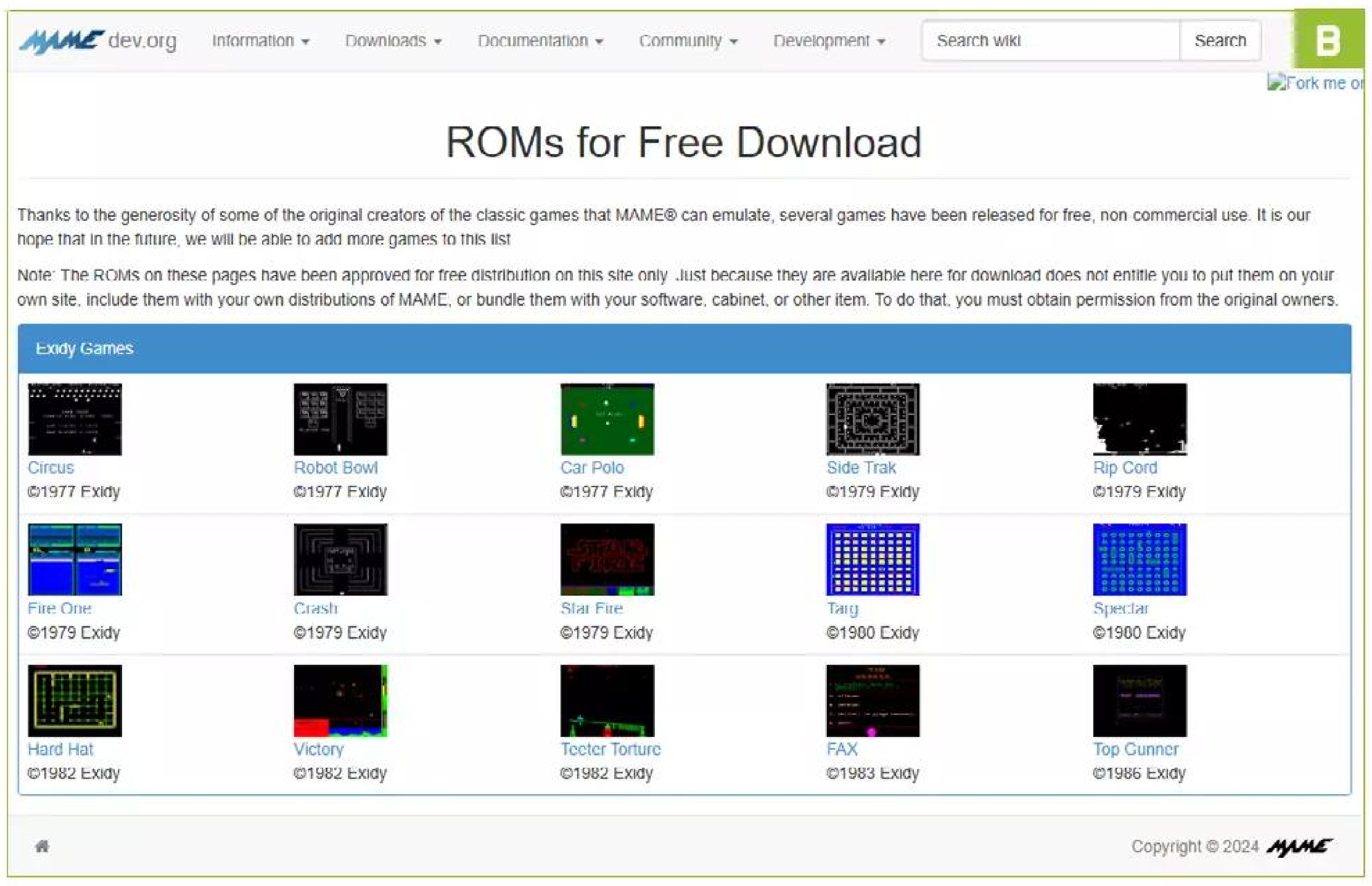
Specify a location for extracted files.

1 SETTING UP MAME

Open your browser, and use the above link to visit the MAME Downloads page. Download and run the program (currently mame0273b_64bit.exe). As you'll see, this is a 7-Zip self extracting archive. This dumps the files directly to the current location, so you'll need to create a container folder, eg. 'MAME' in your chosen directory to store them neatly. [**Image A**]

» Once this is complete, open your target folder and create a shortcut for mame.exe on your desktop for easy access.

» If you browse through the folder, you'll notice there's a folder named 'roms', where games are stored. The MAME website maintains an archive of free ROMS (www.mamedev.org/roms).



ROMs for Free Download

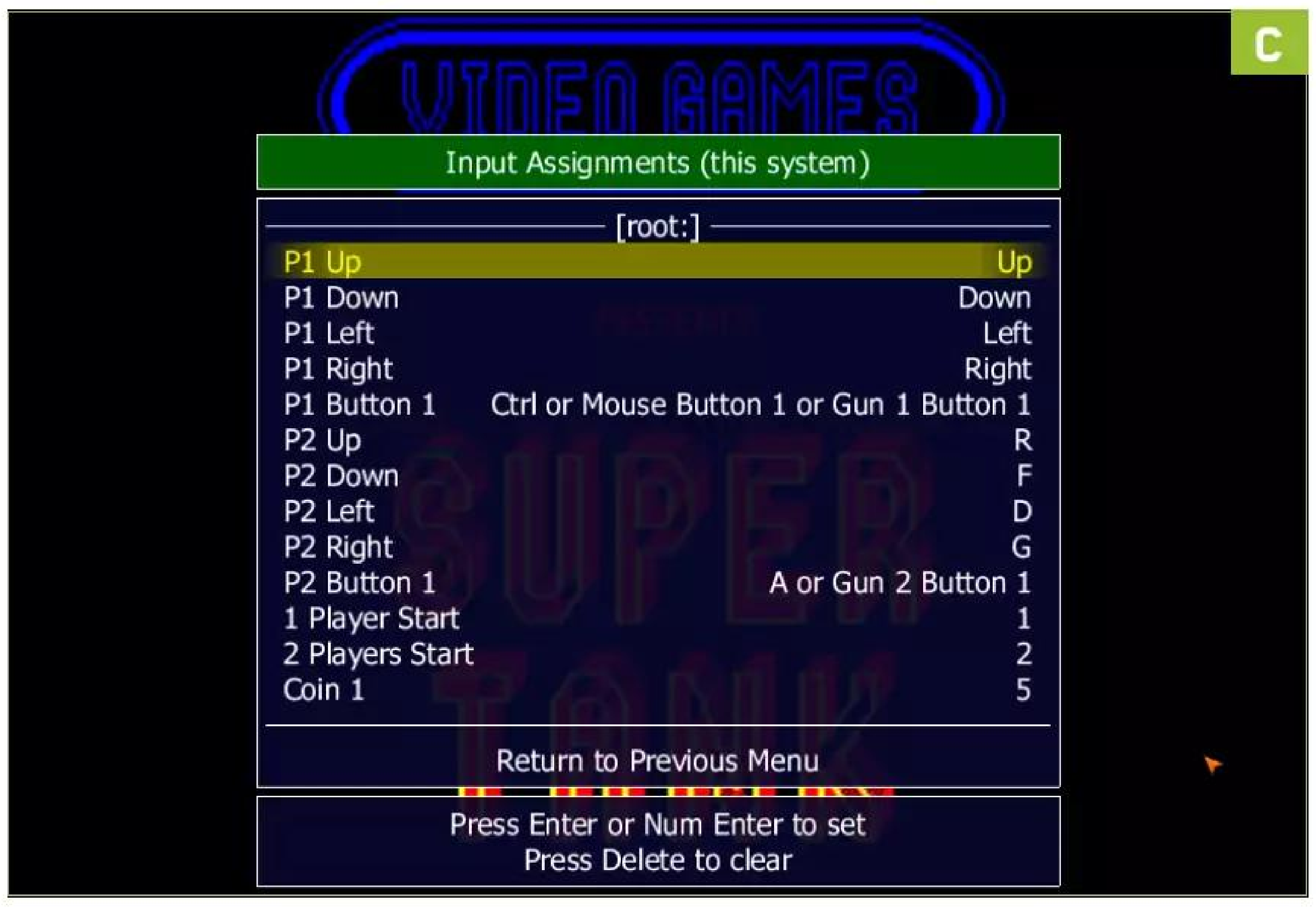
Thanks to the generosity of some of the original creators of the classic games that MAME® can emulate, several games have been released for free, non commercial use. It is our hope that in the future, we will be able to add more games to this list

Note: The ROMs on these pages have been approved for free distribution on this site only. Just because they are available here for download does not entitle you to put them on your own site, include them with your own distributions of MAME, or bundle them with your software, cabinet, or other item. To do that, you must obtain permission from the original owners.

Exidy Games

Circus ©1977 Exidy	Robot Bowl ©1977 Exidy	Car Polo ©1977 Exidy	Side Trak ©1979 Exidy	Rip Cord ©1979 Exidy
Fire One ©1979 Exidy	Crash ©1979 Exidy	Star Fire ©1979 Exidy	Targ ©1980 Exidy	Spectar ©1980 Exidy
Hard Hat ©1982 Exidy	Victory ©1982 Exidy	Teeter Torture ©1982 Exidy	FAX ©1983 Exidy	Top Gunner ©1986 Exidy

Copyright © 2024 MAME



Input Assignments (this system)

[root:]

P1 Up	Up
P1 Down	Down
P1 Left	Left
P1 Right	Right
P1 Button 1	Ctrl or Mouse Button 1 or Gun 1 Button 1
P2 Up	R
P2 Down	F
P2 Left	D
P2 Right	G
P2 Button 1	A or Gun 2 Button 1
1 Player Start	1
2 Players Start	2
Coin 1	5

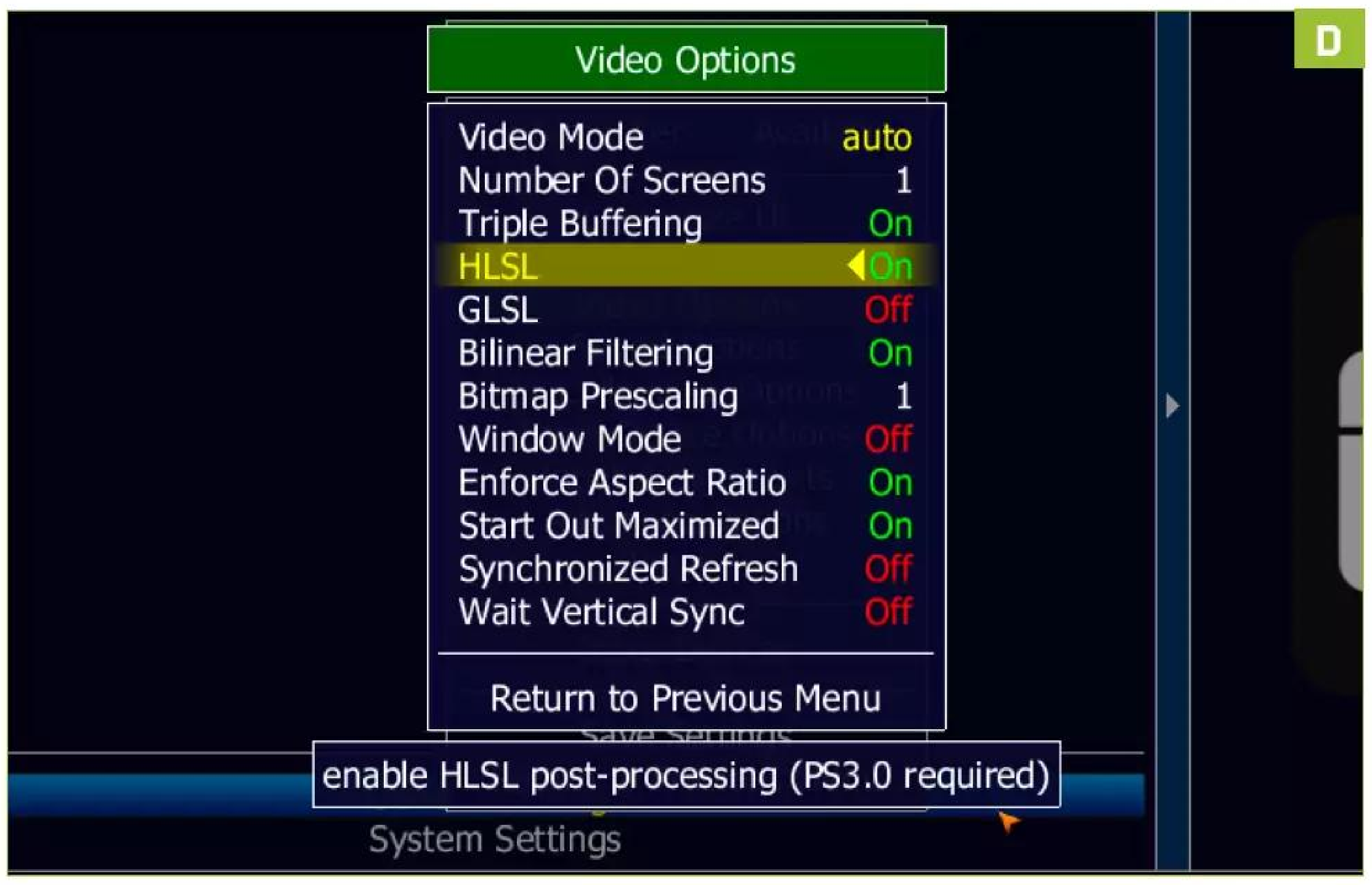
Return to Previous Menu

Press Enter or Num Enter to set
Press Delete to clear

The original creators have given permission for these games to be distributed by the site only for your personal use. In other words, you can't host them elsewhere or include them with a copy of MAME you give to anyone else. [**Image B**]

» Choose a ROM image, eg. 'Super Tank', then download the relevant ZIP file. You can now extract the folder, eg. 'supertnk' to the MAME 'roms' directory.

» Next, run mame.exe either directly from the folder or via the Desktop shortcut you created earlier. The interface can seem overwhelming at first, as it defaults to a list of all supported titles.



Video Options

Video Mode	auto
Number Of Screens	1
Triple Buffering	On
HLSL	On
GLSL	Off
Bilinear Filtering	On
Bitmap Prescaling	1
Window Mode	Off
Enforce Aspect Ratio	On
Start Out Maximized	On
Synchronized Refresh	Off
Wait Vertical Sync	Off

Return to Previous Menu

enable HLSL post-processing (PS3.0 required)

© WWW.MAMEDEV.ORG

» Fix this by selecting the 'Available' option just below 'Unfiltered'. At this stage, you can just double-click your chosen title to begin. However, individual titles can have different ways of mapping controls.

» To see these, press the 'Tab' button, then press Enter twice to choose 'Input Settings' > 'Input Assignments (This System). For instance, in the case of 'Super Tank', a player needs to press '5' to insert a coin. [Image C]

» If you want to map new keys to these controls, scroll down to the option in question, eg. 'Coin 1', then press Enter. You can now select a new key, eg. 'c'. Press Tab when you're done to return to the main game screen.

2

MANAGING MONITORS

If you've already taken the time to play one of your beloved arcade games in MAME, you may find it doesn't bear much resemblance to what you remember. This reflects the realities of modern computer screens, which use 16:9 instead of 4:3 aspect ratios. The familiar blurring effect of CRT monitors is also noticeably absent.

» You can view the and change the current video configuration by accessing 'General Settings' > 'Video Options' from the main MAME screen.

» Once enabled, 'Triple Buffering' will create three separate drawing buffers. One is displayed on the screen as the others are being drawn to. This can minimize screen 'tearing', making for smoother gameplay.

» HLSL (High-Level Shader Language) is designed to simulate the effects old-school arcade monitors had on video. You can enable this feature from the 'Video Options' menu [Image D], but it also needs to match your own monitor's aspect ratio.

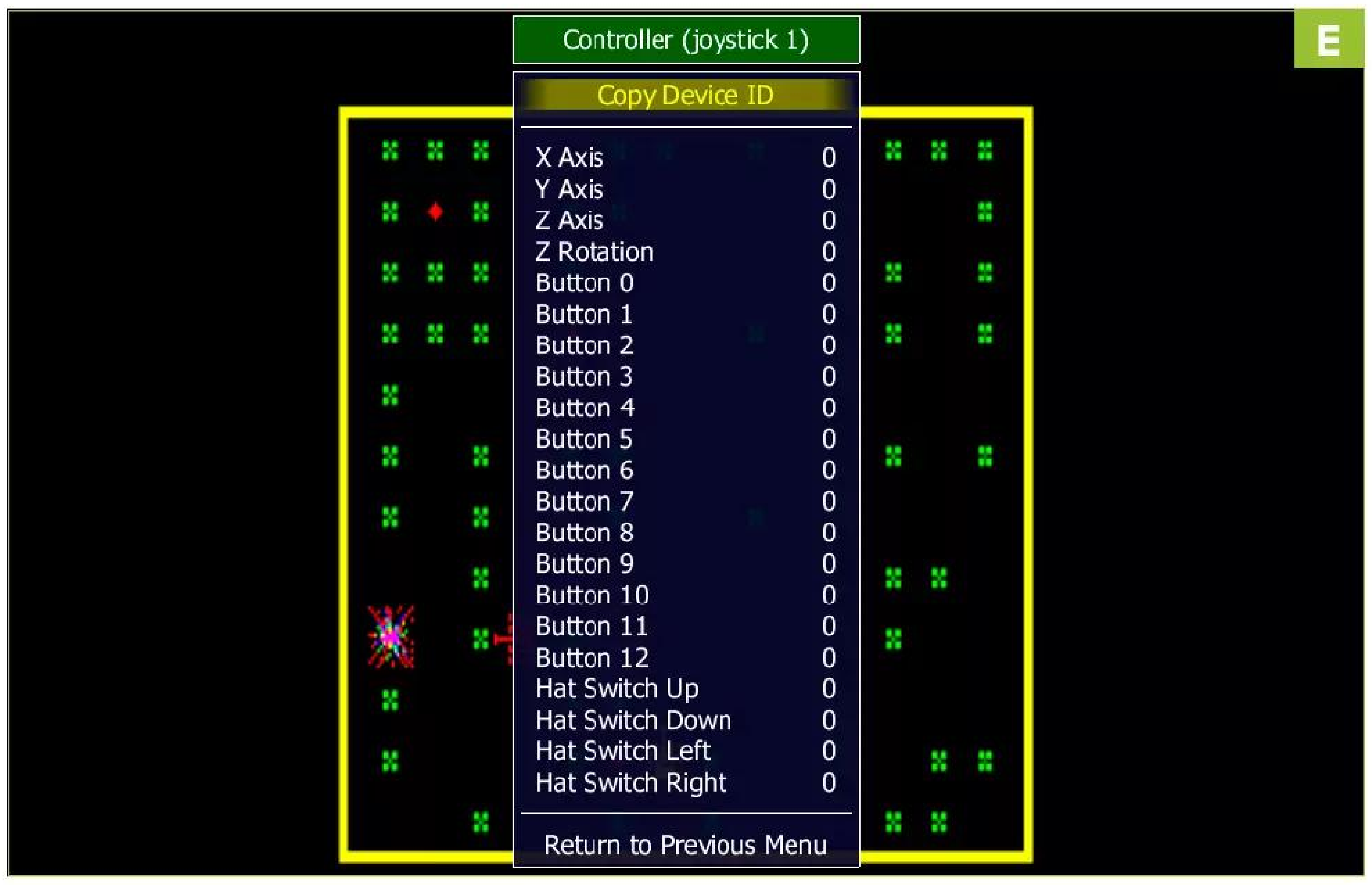
» The best way to do this is via the mame.ini configuration file. To create this, return to the 'General Settings' menu, then choose 'Save Settings'. The file will then be created in the root 'mame' directory. Open this in Notepad.

» Scroll down to 'DIRECT3D POST-PROCESSING' to see options related to HLSL. From here, you can set hlsl_enable to '1' if you wish.

» If you do this, find the 'OSD VIDEO OPTIONS' section and change 'video' from 'auto' to 'd3d'. This is necessary because HLSL requires Direct 3D support. Under 'OSD ACCELERATED VIDEO OPTIONS', make sure 'filter' is also set to '0'. This prevents any filtering effects from interfering with how HLSL operates.

» The optimum HLSL settings to use here will vary depending on your virtual console, game, and monitor. MAME's documentation provides a comprehensive list of how to fine-tune each of these at: https://docs.mamedev.org/advanced/hlsl.html

» If you open the 'ini' folder in the 'mame' directory, you'll also see there's a number of .ini files in 'presets'. These contain optimum rendering settings for popular consoles like the Game Boy.

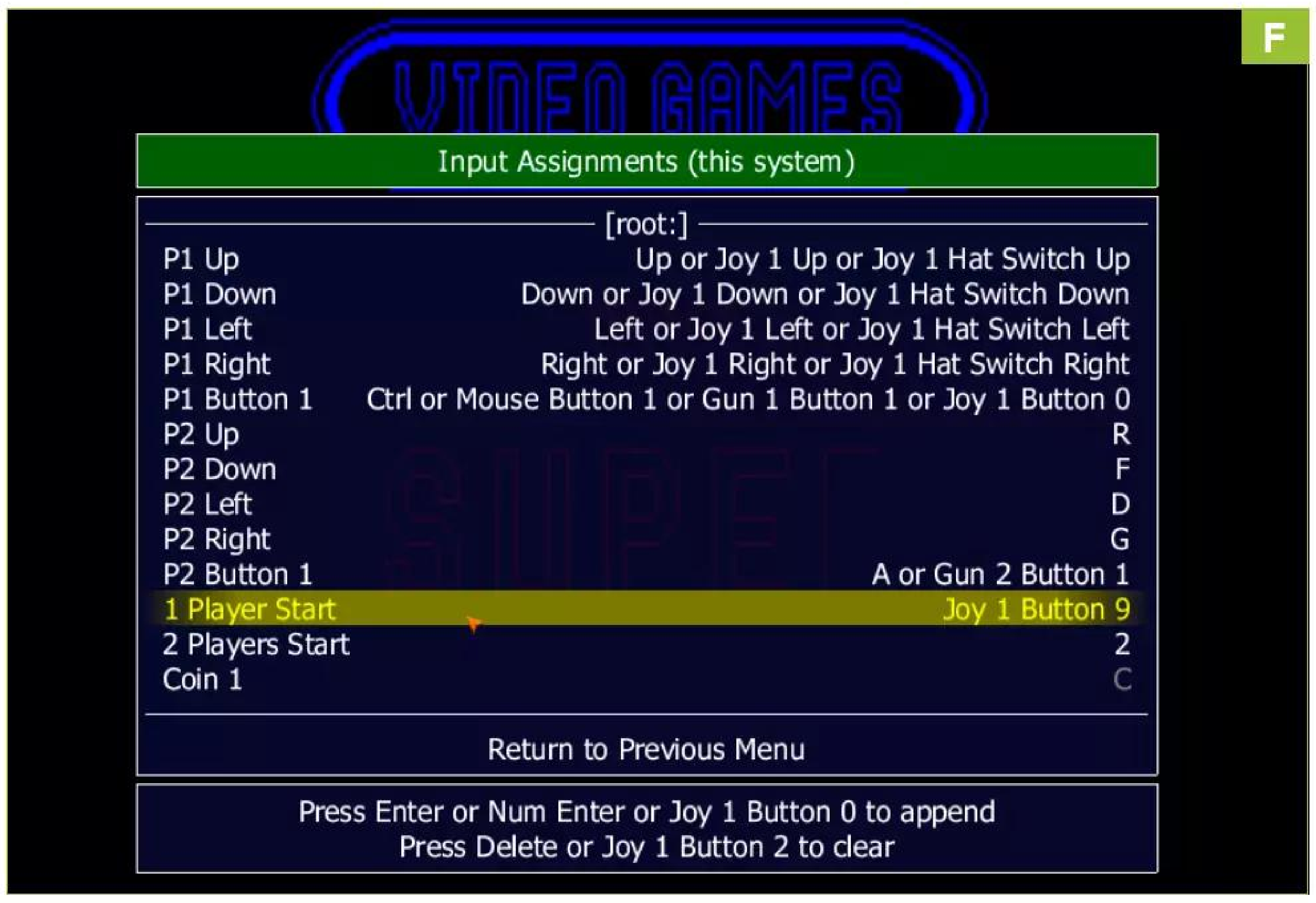

E

Controller (joystick 1)

Copy Device ID

X Axis	0
Y Axis	0
Z Axis	0
Z Rotation	0
Button 0	0
Button 1	0
Button 2	0
Button 3	0
Button 4	0
Button 5	0
Button 6	0
Button 7	0
Button 8	0
Button 9	0
Button 10	0
Button 11	0
Button 12	0
Hat Switch Up	0
Hat Switch Down	0
Hat Switch Left	0
Hat Switch Right	0

Return to Previous Menu


F

Input Assignments (this system)

[root:]

P1 Up	Up or Joy 1 Up or Joy 1 Hat Switch Up
P1 Down	Down or Joy 1 Down or Joy 1 Hat Switch Down
P1 Left	Left or Joy 1 Left or Joy 1 Hat Switch Left
P1 Right	Right or Joy 1 Right or Joy 1 Hat Switch Right
P1 Button 1	Ctrl or Mouse Button 1 or Gun 1 Button 1 or Joy 1 Button 0
P2 Up	R
P2 Down	F
P2 Left	D
P2 Right	G
P2 Button 1	A or Gun 2 Button 1
1 Player Start	Joy 1 Button 9
2 Players Start	2
Coin 1	C

Return to Previous Menu

Press Enter or Num Enter or Joy 1 Button 0 to append
Press Delete or Joy 1 Button 2 to clear

3

CONFIGURING CONTROLLERS

In the first step, we covered how to change key mappings for in-game controls. You can play games this way, but it's far better to use a controller, particularly if a title supports more than one player.

» First, connect your controller, then launch your chosen game in MAME. Return to the 'Input Settings' menu as outlined in Step One. From here, choose 'Input Devices'. This menu should list both your keyboard and any connected controllers.

» If you select this, by default the button mappings will all be listed as '0' (unassigned). [Image E]

» Fix this by returning to the 'Input Settings Menu' and choosing 'Input Assignments (This System). This means the controls you choose are specific to this particular virtual hardware.

» From here, you can map new controls to your chosen joypad in the same way as for keys. For instance, in 'Super Tank', the '1 Player Start' is mapped to the number 1 on the keyboard by default. Press Enter on this, then a button on your controller, eg. Start to assign a new control. [Image F]

» Controller configuration files are stored in the 'ctrlr' folder in the 'root' MAME directory. If you open this, you'll see tsome preconfigured files in there for popular controllers like the Scorpion XG-2.

» One advantage of these configuration files is that you can remap keyboard keys to controller buttons, eg.

```
<remap origcode="KEYCODE_UP"
newcode="KEYCODE_8PAD" />
```

» This means you can use a controller to play videogames that were originally designed only to be used with a keyboard.

» MAME's online documentation contains details of this and other configuration options: https://docs.mamedev.org/advanced/ctrlr_config.html

» If you do create a configuration file, we also recommend creating a 'Stable Controller ID' using the 'mapdevice' XML element. This ensures that if a gamepad, for instance, has been assigned to 'Joy 1', it will be recognized as 'Joy 1' every time you play the game, eg.

```
<mapdevice device="XInput Player 1"
controller="JOYCODE_1" />
```

Use Windows Phone Link's new features

YOU'LL NEED THIS

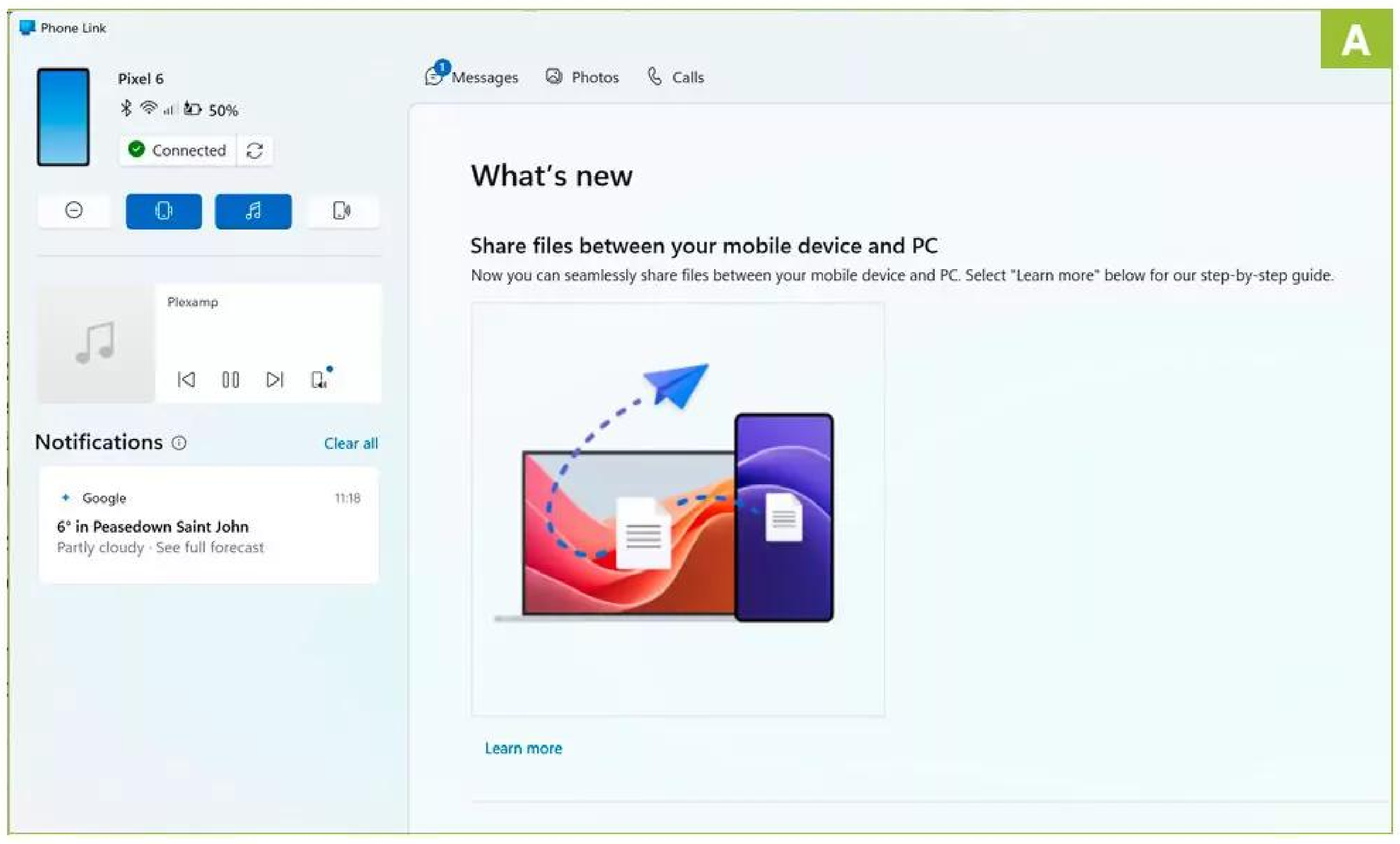
AN ANDROID CELLPHONE
Windows Phone Link for Windows (free)

BEING ABLE TO LINK your phone to your PC is nothing new, but there have been some improvements in recent Windows 11 releases that mean it's worth taking another look at.

Not only can you view your photos, call logs and text messages, and deal with notifications; you can control music playback and move your phone in and out of silent mode. It is possible to interact with some of your Android apps, too, but only if you're using specific Samsung models.

Much of this functionality is still Android-only. This is a shame, as the capabilities of an Apple Mac to communicate with an iPhone, and use it as a remote camera via its Continuity Camera feature, is an example of the way cellphones and laptops can work together.

So here's how to get started with Windows 11's Phone Link with Android, and a look at what has been added to the software in recent updates. –IAN EVENDEN



What's new

Share files between your mobile device and PC

Now you can seamlessly share files between your mobile device and PC. Select "Learn more" below for our step-by-step guide.

1 PHONE LINK

We're going to use Windows 11's Phone Link here, specifically the updated version found in version 24H2 of the OS. It updates through the Microsoft Store rather than Windows Update, so it's worth opening the app and clicking Downloads > Get Updates > Update All to make sure you've got the latest version, though it may also update itself the first time you open it. If you installed Windows from scratch or set up a new PC recently, you'll have been asked to link your phone during the setup process, but you can also do it by opening the app and clicking Add Device. You'll need your phone's Bluetooth and Wi-Fi turned on, and it helps if both it and your PC are connected to the same network, although this isn't mandatory. You'll also need the Link to Windows app on your phone, which you'll find in the Google Play Store, and be signed in with the same Microsoft account on both devices. You may also need to open Settings > Bluetooth and Devices > Mobile Devices, and switch on both 'Allow this PC to access your mobile devices' and 'Phone Link'.

2 ADD A DEVICE

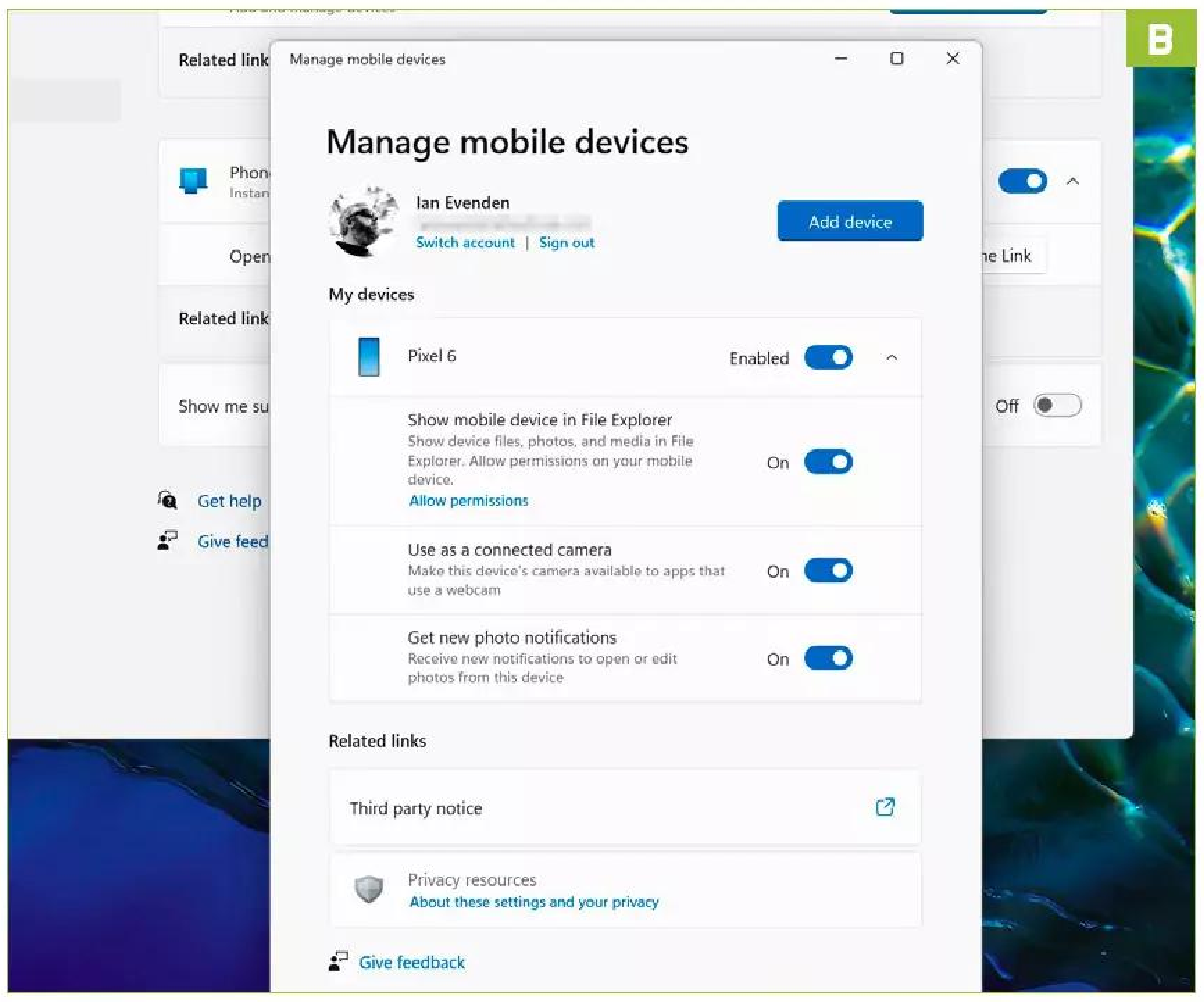
If your phone isn't already linked to your PC, then open Phone Link and click the Add Device button in Settings > Devices. Choose between Android or iPhone, and use your phone's camera to read the QR code that appears. These time out in ten minutes, and will be replaced by a new one if you leave it too long. There's an option to proceed without using the QR code if you'd prefer to do so, which requires you to input a short URL into your phone's browser, and then type in a verification code that's displayed on your PC.

3 YOU'RE LINKED

Once your phone and PC are linked, you'll be able to explore the Phone Link window. It's organized into tabs across the top, with a sidebar at the left that shows you notifications, media controls, and the battery level, as well as allowing you to switch between do not disturb, silent, and full ringer modes. There's also a settings icon at the top right, with a three-dot button that opens a What's New page that shows what's been added in the latest update [**Image A**].

4 FILE TRANSFER

One of the latest additions to Phone Link is the ability to easily transfer files wirelessly between your phone and PC. Mounting the phone's storage as a removable drive might seem easy to do, but this has traditionally eluded Windows. There have been a few solutions—often manufacturer dependent—but Phone Link provides the service for every phone that it can connect to. It doesn't appear in the Phone Link app itself; rather in the share menu on both your PC and Android phone. Select a file, then use the context-sensitive menu to share it to Phone Link. Alternatively, if you open up the Settings menu in the Phone Link app, you'll find an option there to 'Show mobile device in File Explorer' [**Image B**]. The first time you try to use this, you'll need to



Manage mobile devices

Ian Evenden
[redacted]

Pixel 6 — Enabled

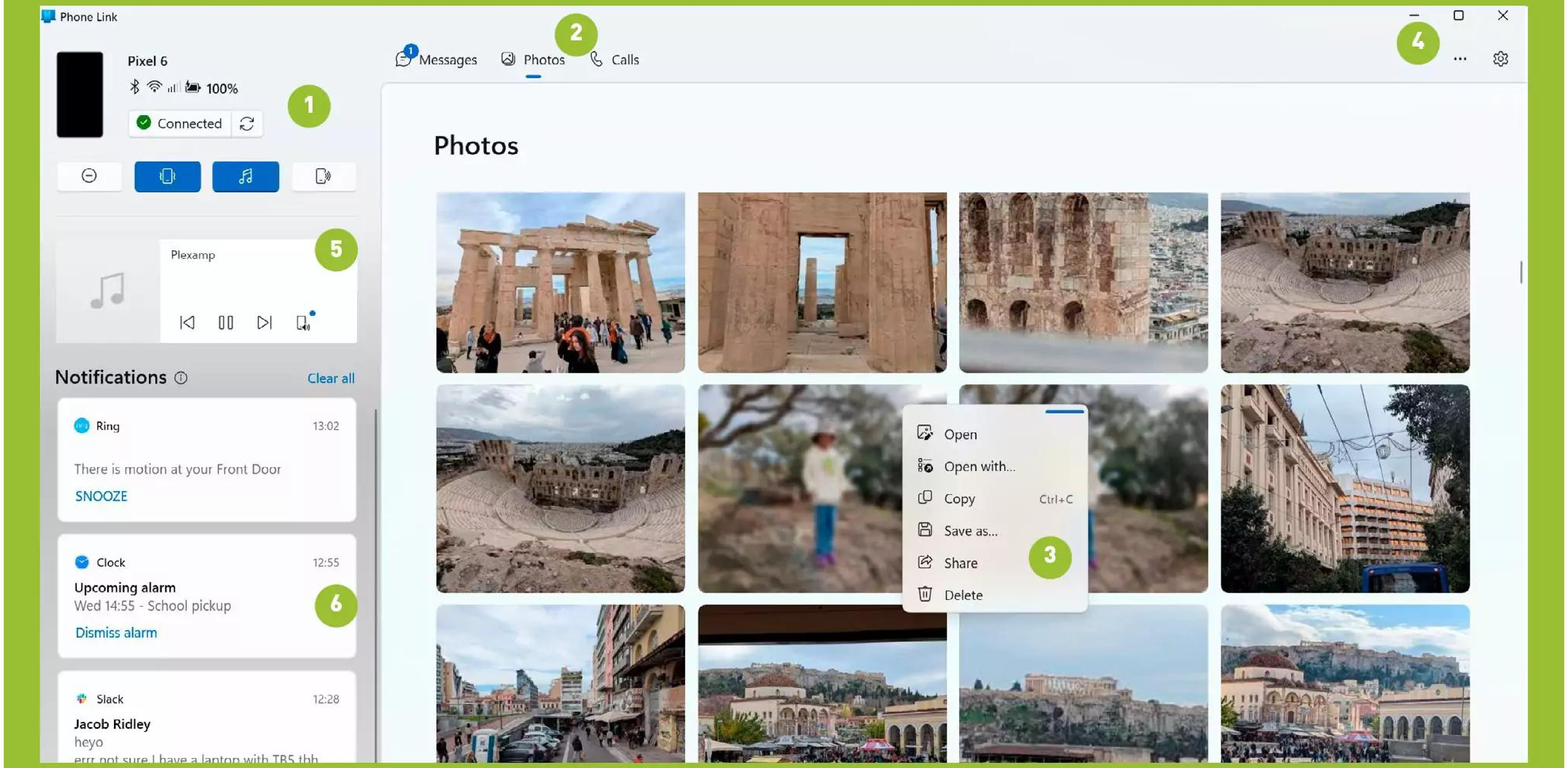
Show mobile device in File Explorer — On
Show device files, photos, and media in File Explorer. Allow permissions on your mobile device.

Use as a connected camera — On
Make this device's camera available to apps that use a webcam

Get new photo notifications — On
Receive new notifications to open or edit photos from this device

© MICROSOFT

PHONE LINK'S INTERFACE


Phone Link
Pixel 6
100%
Connected
1
Messages
Photos
Calls
2
4
Plexamp
5
Notifications
Clear all
6
Photos
Open
Open with...
Copy
Ctrl+C
Save as...
Share
Delete
3

Ring 13:02
There is motion at your Front Door
SNOOZE

Clock 12:55
Upcoming alarm
Wed 14:55 - School pickup
Dismiss alarm

Slack 12:28
Jacob Ridley
heyo

1. PHONE INFO
See the battery level, connection status, and more here.

2. TABS
Switch between tabs showing SMS messages, photos, and your call log.

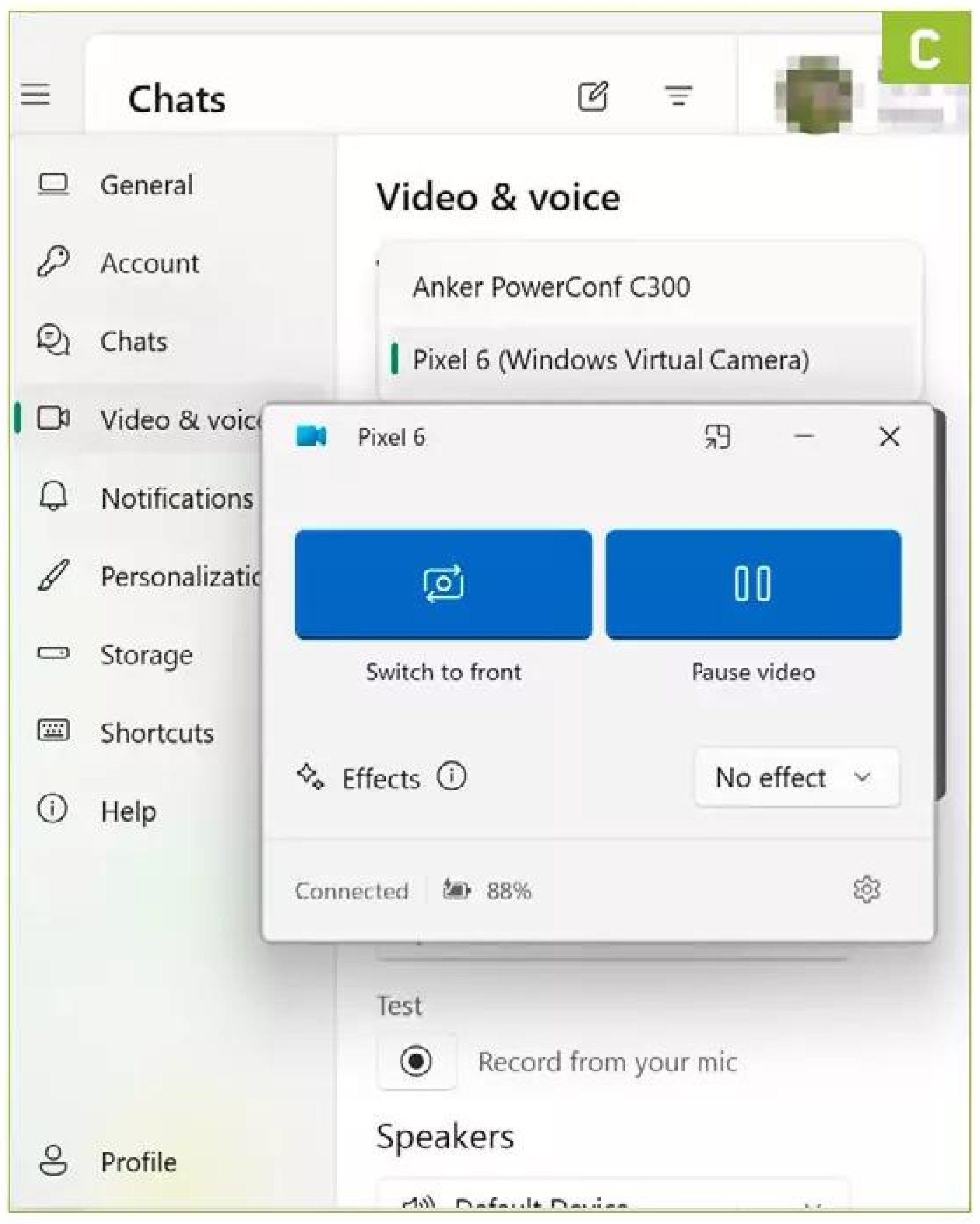
3. RIGHT-CLICK
Save photos onto your PC, or open them in an editing app.

4. SETTINGS
Open the Settings menu, or access the 'New Features' page.

5. MEDIA CONTROLS
Take charge of the music playing through your phone.

6. NOTIFICATIONS
These respect your phone's privacy settings, and won't show sensitive text.

give the Phone Link app on your Android phone access to your phone's files—a notification will take you to the relevant part of the Settings app—but after this, access will be seamless. By default, transferred files appear in a Phone Link subfolder within your Downloads folder. You can change this via Phone Link > Settings > Features > Additional Settings.


C
Chats
General
Account
Chats
Video & voic
Notifications
Personalizatic
Storage
Shortcuts
Help
Profile
Video & voice
Anker PowerConf C300
Pixel 6 (Windows Virtual Camera)
Pixel 6
Switch to front
Pause video
Effects
No effect
Connected
88%
Test
Record from your mic
Speakers

5 VIRTUAL CAMERA

Another recently added feature is the ability to use your cellphone as a wireless webcam. This is probably only going to be useful for desktop PC users, as laptops tend to have built-in cameras, but having one that can rove further away from your desk can be handy. To use it, you'll need to activate it in Phone Link's Settings menu, then open a video chat app, such as Skype or WhatsApp. The connected phone should appear in the list of available cameras with 'Windows Virtual Camera' after its name. Select it, and you'll need to unlock your phone, then give permission to use the camera. The feed from your phone camera will appear in the app [**Image C**]. You can pause the video, switch between front and rear cameras, and add effects to the video feed. The camera doesn't appear in the list of microphones, so you can't move too far away from whatever you're using to pick up audio if you still want to be heard.

6 PHONE LINK WIDGET

Phone Link now has a widget, so you can keep an eye on phone notifications without having the app open. To get it, open the Windows 11 Widgets sidebar, then its Settings menu from the top-right corner. Choose 'Discover new widgets', and you'll find Phone Link on the list. You can pin it to the top of your Widgets screen, and the widget can be resized. It will display your phone notifications, which can be cleared directly from the widget, as well as the battery level.

7 MAKE CALLS FROM SMS

This is a bit of a power-user feature, but one that might save some time if you're a regular user of Phone Link. SMS messages appear in one tab, and your voice call history in the other. The ability to place a call using the contact information from a text message has been added, mirroring the functionality you'd find in Android—all you have to do is click the new phone handset icon (which looks like the sort of landline handset we were using in the 90s—another example of the design nostalgia that sees a floppy disk still used as the save icon elsewhere) and the cell number the SMS came from will appear. Click it to place a voice call.

Declutter Windows desktop for 2025

YOU'LL NEED THIS

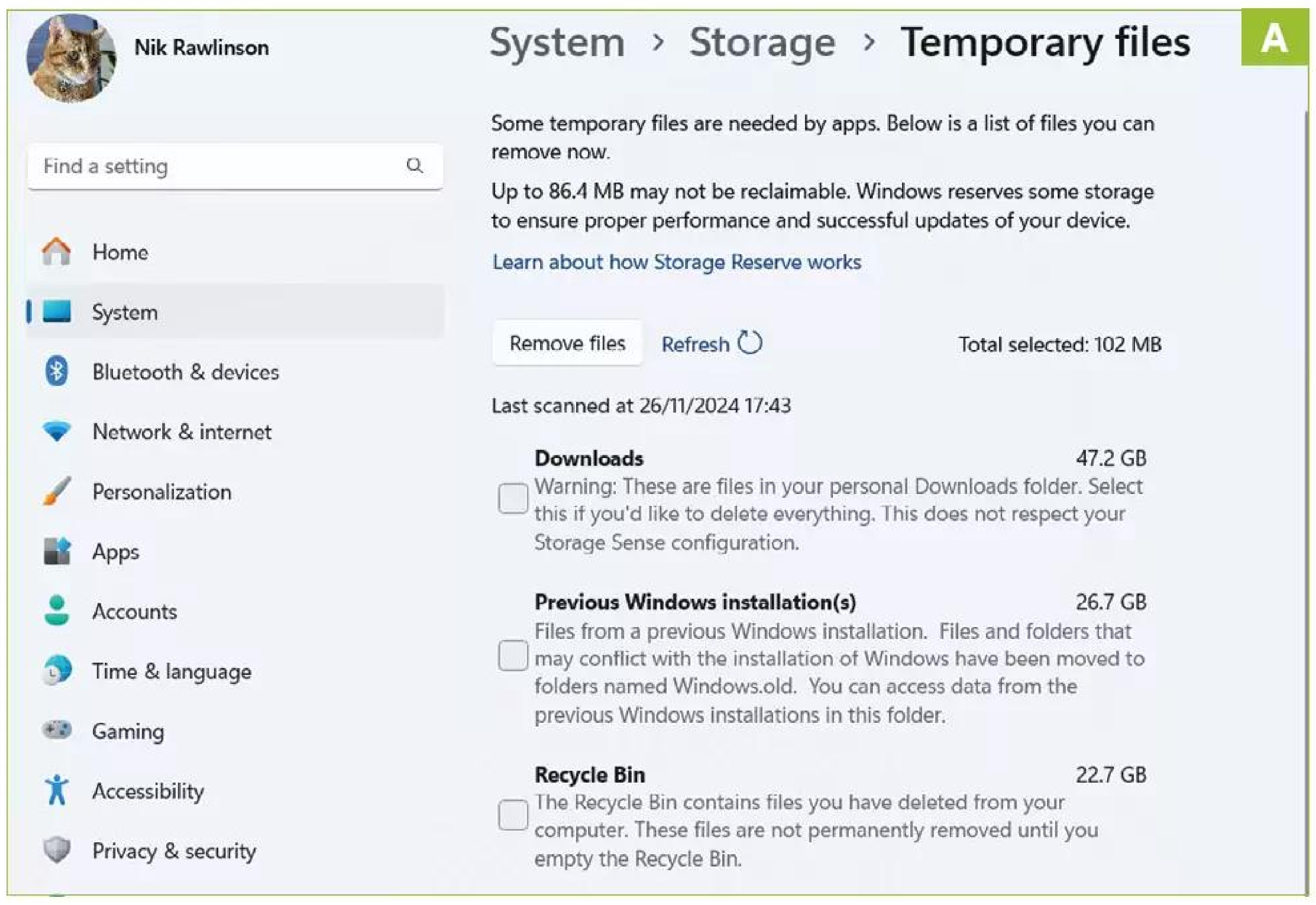
WINDOWS 10 OR 11
DesktopOK

YOU'VE PROBABLY HEARD the phrase, 'tidy desk, tidy mind'. This also applies to the digital realm. The trouble is, Windows' desktop is too convenient a place to save files you're going to need in the near future. Why bury them several folders deep?

For one thing, because your desktop can get cluttered. Secondly, Microsoft has given us more efficient alternatives to using the desktop. Windows 10 and 11 have excellent built-in search tools, going beyond indexing files on the basis of name alone to pull up a list of results from within the contents of a file. Saving files to your desktop can also slow down your computer, as the desktop is essentially a folder itself. If you have an old PC, it can really start to suffer.

Start by creating a backup of your system so that if you delete something you later discover you need, you can recover it. If you're only going to clean up your desktop, the simplest option is to plug in an external drive and drag across a copy of the desktop contents. As part of our clean-up, we're also going to look at where we're wasting space with files we probably no longer need.

If you're going to follow those steps, perform a full backup using a tool like IDrive (www.idrive.com). Although its software is closely associated with its own online backup service, you can also use it to make local backups for free. –**NIK RAWLINSON**



System › Storage › Temporary files

Some temporary files are needed by apps. Below is a list of files you can remove now.

Up to 86.4 MB may not be reclaimable. Windows reserves some storage to ensure proper performance and successful updates of your device.

Learn about how Storage Reserve works

Total selected: 102 MB

Last scanned at 26/11/2024 17:43

☐ **Downloads** 47.2 GB
Warning: These are files in your personal Downloads folder. Select this if you'd like to delete everything. This does not respect your Storage Sense configuration.

☐ **Previous Windows installation(s)** 26.7 GB
Files from a previous Windows installation. Files and folders that may conflict with the installation of Windows have been moved to folders named Windows.old. You can access data from the previous Windows installations in this folder.

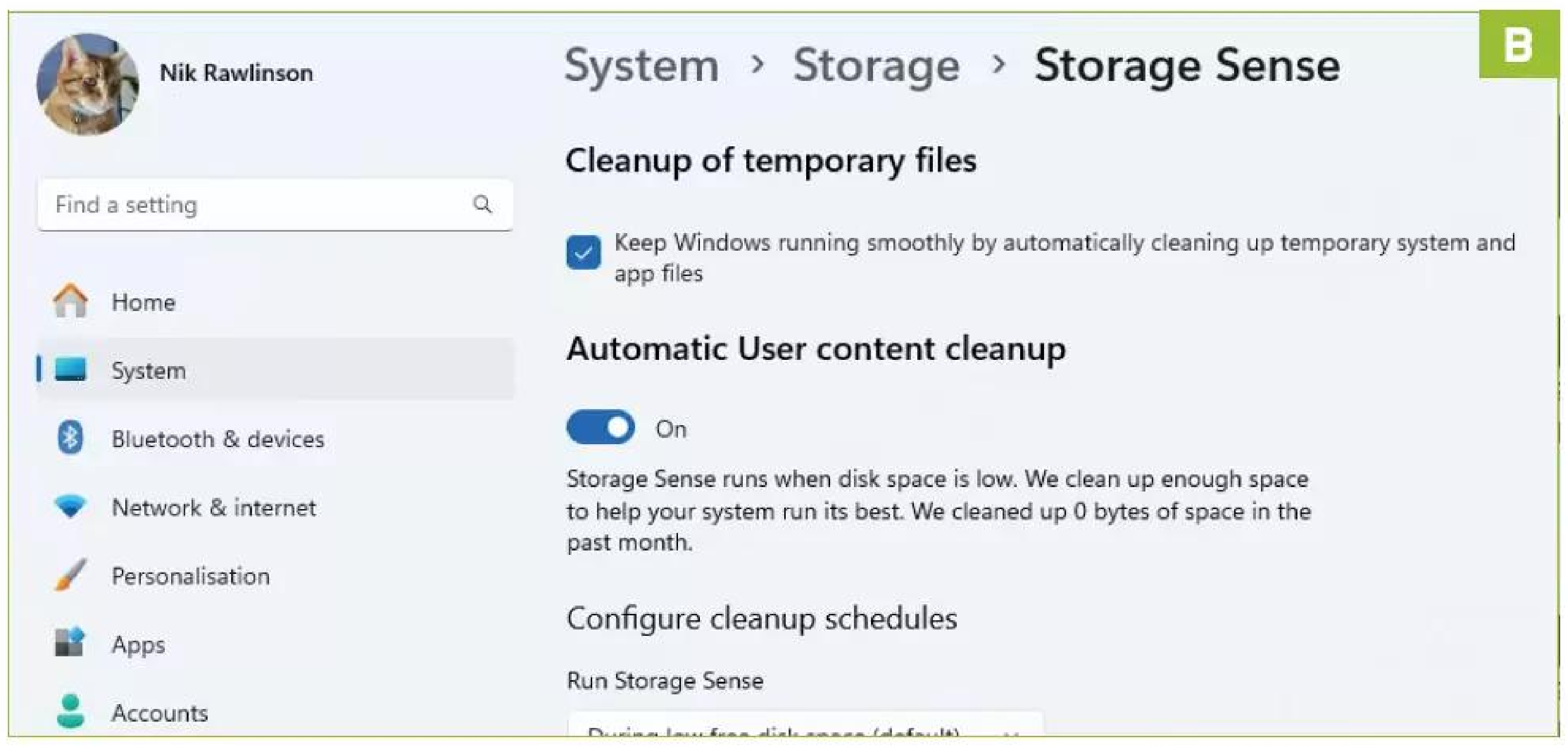
☐ **Recycle Bin** 22.7 GB
The Recycle Bin contains files you have deleted from your computer. These files are not permanently removed until you empty the Recycle Bin.

1 REMOVE UNWANTED FILES FROM WINDOWS

Press Windows key+I to open Settings, then click System, followed by Storage. Windows will do an audit of your current drive use, and present its findings. Cast an eye over this screen and get rid of any clutter you no longer need.

» In our case, we have 96.4GB of temporary files on our drive, and 111GB of 'other' data. Click 'Temporary files' to see what this category comprises. This includes 47.2GB in our Downloads folder [**Image A**], almost half that much in the recycle bin, and 26.7GB of previous Windows installations. Those are huge figures, much bigger than the sections Windows has automatically selected for deletion (pre-ticked boxes).

» Although we're fairly sure we could get rid of our downloads, we'll leave them where they are for the moment, but click the boxes next to everything else. We'll also untick the Thumbnails box so previews of our pictures and videos don't need to be recreated. We'll then click the 'Remove files' button at the top of the list to delete the associated data. Before doing the same yourself, make sure you're not going to lose anything you need, because the files really will be removed for good—not just moved to temporary storage, like how they are when you send them to the bin.



System › Storage › Storage Sense

Cleanup of temporary files

☑ Keep Windows running smoothly by automatically cleaning up temporary system and app files

Automatic User content cleanup

On

Storage Sense runs when disk space is low. We clean up enough space to help your system run its best. We cleaned up 0 bytes of space in the past month.

Configure cleanup schedules

Run Storage Sense

2 TURN ON STORAGE SENSE

Now that you've taken the first step, tell Windows to keep an eye on things. Click back to the Storage section, then click Storage Sense. This is a feature that Microsoft introduced with Windows 10, and it automatically runs—assuming you've enabled it—whenever drive space starts to get low.

» At its most basic, on both Windows 10 and 11, it will automatically delete temporary files and the contents of your recycle bin. However, on Windows 11, it can also delete local copies of files you've synchronized to OneDrive on the basis that you can recover them from the cloud when they're required. It isn't designed to help keep your desktop in order, but you can use it to reduce the size of the desktop folder with a little bit of tweaking.

» In Windows 11, turn on Storage Sense by clicking the slider below 'Automatic User content cleanup' so it slides to the right ('On'), and turns blue [**Image B**]. Now, scroll to the bottom, and below your name, you should see an option for 'Content will become online-only if not opened for more than'. If you've not made any changes, this will be set to '30 days (default)'.

» What this means is that if you've not touched a file that's synchronized to your OneDrive account for at least that time period, it deletes the local copy, but keeps a marker for it so that if you try to open it again, it can retrieve it for you, and you'll be none the wiser. You can

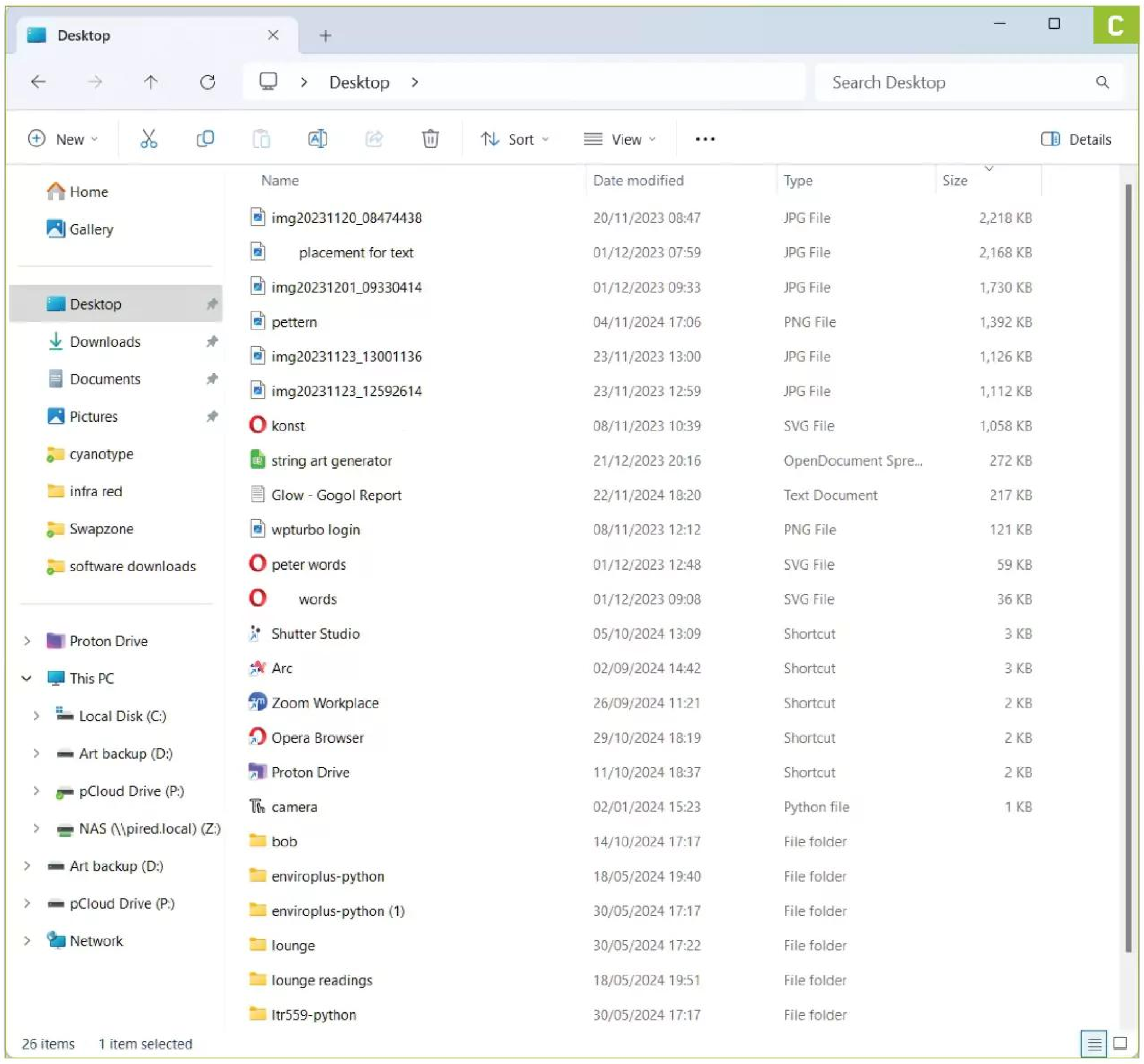
© MICROSOFT

change the interval to as little as '1 day' or as much as '60 days' by selecting from the menu.

» If you don't see this option, it's because your computer isn't logged into OneDrive. Change this by clicking the OneDrive icon on the Windows taskbar, or by launching OneDrive from the Start menu.

» Check that your desktop files are included in the selection of items you're syncing to OneDrive. Click the OneDrive icon again, then the top-right cog in the box that appears, followed by Settings. Click 'Sync and backup' in the sidebar, then the 'Manage backup' button in the main section of the window. Here, you'll find five folders you can back up to the cloud alongside the local OneDrive folder that's automatically synchronized.

» Make sure the Desktop slider is turned on (gray), so it shows 'Backed up'. When space starts running low, the contents of your messy desktop will be removed from your machine.



Name	Date modified	Type	Size
img20231120_08474438	20/11/2023 08:47	JPG File	2,218 KB
placement for text	01/12/2023 07:59	JPG File	2,168 KB
img20231201_09330414	01/12/2023 09:33	JPG File	1,730 KB
pettern	04/11/2024 17:06	PNG File	1,392 KB
img20231123_13001136	23/11/2023 13:00	JPG File	1,126 KB
img20231123_12592614	23/11/2023 12:59	JPG File	1,112 KB
konst	08/11/2023 10:39	SVG File	1,058 KB
string art generator	21/12/2023 20:16	OpenDocument Spre...	272 KB
Glow - Gogol Report	22/11/2024 18:20	Text Document	217 KB
wpturbo login	08/11/2023 12:12	PNG File	121 KB
peter words	01/12/2023 12:48	SVG File	59 KB
words	01/12/2023 09:08	SVG File	36 KB
Shutter Studio	05/10/2024 13:09	Shortcut	3 KB
Arc	02/09/2024 14:42	Shortcut	3 KB
Zoom Workplace	26/09/2024 11:21	Shortcut	2 KB
Opera Browser	29/10/2024 18:19	Shortcut	2 KB
Proton Drive	11/10/2024 18:37	Shortcut	2 KB
camera	02/01/2024 15:23	Python file	1 KB
bob	14/10/2024 17:17	File folder	
enviroplus-python	18/05/2024 19:40	File folder	
enviroplus-python (1)	30/05/2024 17:17	File folder	
lounge	30/05/2024 17:22	File folder	
lounge readings	18/05/2024 19:51	File folder	
ltr559-python	30/05/2024 17:17	File folder	

26 items 1 item selected

3 DRAG YOUR LARGEST FILES TO CORRECT FOLDERS

However, as we mentioned earlier, when Storage Sense removes a local file, it leaves a placeholder behind, so you can open it as easily as you would if it was still stored on your drive. In the case of a messy desktop, therefore, Storage Sense isn't going to help you tidy things up, even if it does reduce the amount of data on your drive.

» Your next job is either to sort things out within Windows or use third-party software. We recommend starting with Windows, but rather than dragging things around the desktop, open File Explorer and click Desktop. That way, you can use File Explorer's views and sorting options to complete the job more quickly.

» Start by clicking the header of the Size column [**Image C**] to move your biggest files to the top of the list. This will help you more quickly identify your worst space hogs. As you can see from our screenshot [**Image C**], five of the six largest files on our desktop are JPEGs. After checking, we want to keep them, so we'll drag them into the Pictures folder [**Image C**]. The same goes for the large SVG files, which are vector images.

» You've probably spotted another image on that list with a .PNG extension. This is a screenshot we've taken with our login details for a website. Rather than move it to our Pictures folder, we'll add the login details to our password manager, Bitwarden (www.bitwarden.com) and delete the file entirely. Leaving screenshots like that lying around is very risky.

» Below these are five shortcuts. Four of these—for Shutter Studio, Arc, Zoom Workplace, and Opera Browser [**Image C**]—are for programs, which we can find just as easily on the Start menu, so they can be deleted. The other, for Proton Drive, is replicated in the sidebar, so that can go, too.

» Where it starts to get complicated is when you get down to the folders. Some of these, like the two enviroplus-python folders, contain code, while the two folders with 'lounge' in their name contain data. There's no uniform way to handle these, so you'll need to make your own decision with anything similar, but our recommendation would be to make directories within your Documents folder for groups like 'data', 'code', and so on, then organize each of these as a subfolder in the appropriate location.

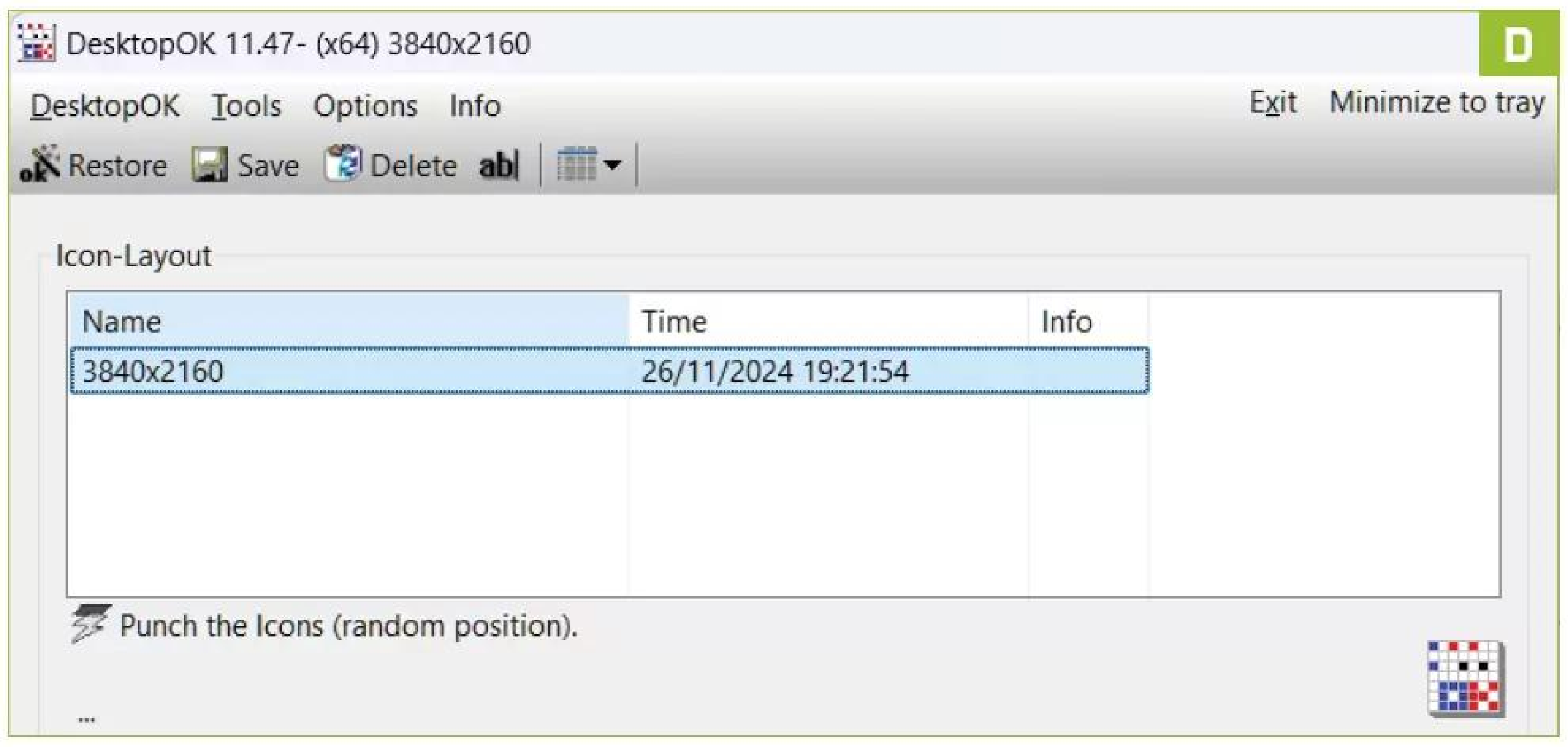
» Continue working your way through the items on your desktop until you've removed as many as you can and filed everything else . This will make the next step much easier.

4 SORT YOUR DESKTOP FILES AND STOP THEM MOVING

Close File Explorer and minimize any windows that are obscuring the desktop. Now, drag the remaining icons to the positions where you'd like them to live. If you just want them arranged along the left-hand border, right-click an empty area on the desktop, then hover over 'Sort by', and select an option from the menu.

» Save repeating what you've just done by using the free program DesktopOK. Visit tinyurl.com/3nzr6hs3, then click the Download link below the screenshot. Click 'DesktopOK_Installer_x64.zip' to download the software. When it's finished, click the file, then 'Extract all' on the toolbar, and save the files in a folder.

» Next, go to that folder and launch the 'desktopOK_Installer_x64.exe' file. When it's finished installing, launch DesktopOK from the Start menu, and immediately click Save. This creates a new entry [**Image D**] in the table in the center of the program window, which records the positions of the icons on your desktop. To check it's worked, move a few icons somewhere else, then select the entry in the table again, followed by the Restore button on the toolbar. Your misaligned icons will jump back to their original positions. ⏻



Name	Time	Info
3840x2160	26/11/2024 19:21:54	

Punch the Icons (random position).

LAB NOTES

ZAK STOREY, CONTRIBUTING EDITOR

The rising cost of the humble PC

GPUs might not be the culprit

THIS MONTH, I was doing a bit of research on a phenomenon that's been afflicting the tech industry. Namely, how the cost of PC parts has skyrocketed over the last decade.

Go back to September 2015 (my first issue), and the Blueprints reveal dramatically different rigs. Yes, there have been hardware advancements—we're not stuck with 16GB of DDR4 on a Turbo build—but if you look at the products, you're getting more for the money, or so it seems.

I did the math, and on the graphics card front, what we all imagine to be the biggest culprit of price hikes, it's honestly not that bad. Take the GTX 660, for instance. It launched at $230 in 2013. With inflation today, that's about $310. The RTX 4060 launched with an RRP of $300.

It's a bit different on the high end, where margins have increased. The GTX 690 debuted at $1000, the RTX 4090 at $1600 But that is an outlier GPU, to be fair, and arguably the way the latest 90 cards are specced is far more wild than the 690 was, mimicking Titans rather than 90s.

So what's the cause? On the one hand, the median household income hasn't kept up with inflation. In the US, average income is up by about 18 percent according to some sources, versus 36 percent inflation from 2013 to 2023. But what's more pressing is how dramatically different PC builds are.

You don't just buy a windowless case, a basic motherboard, some RAM, and key components; you buy coolers, RGB case fans, custom cables, light-up memory, fan controllers—the works. Then there are the multi-monitor setups, gaming chairs, and standing desks. Jump on Instagram, PC Part Picker, Pinterest, or YouTube, and you're bombarded with beautiful illuminated builds and setups.

If you sent this to me in 2014, I'd scream.

Although PCs have become simpler to build, the hobby has become more in-depth. Given how other tech products have fallen in price, there's an expectation (and a justifiable one) that we still want that $1,000 budget, but a $2,000 system for it, and economies of scale just haven't kept up.

JEREMY LAIRD

Contributing Editor

Did you know that 50 percent of AMD's CPUs sold today are still based on the old AM4 socket? So says David McAfee, AMD's head of Client Channel Business. The AM4 socket first appeared back in 2016, while the newest family of Ryzen CPUs for AM4, the Zen 3-based Ryzen 5000 chips, was released in late 2020. But here we are in 2025, and half of AMD's desktop CPU sales are still AM4-based.

That shouldn't be a surprise. CPU performance gains tend to be incremental. A Ryzen 7 5800X3D, for instance, is still a good gaming CPU. Likewise, a 16-core Ryzen 9 5950X will tear through content creation in a thoroughly modern manner.

What's more, as recently as June last year, AMD launched two new-but-old Zen 3 chips for the AM4 socket, the eight-core Ryzen 7 5800XT, and the 16-core Ryzen 9 5900XT. It followed those in October with the six-core Ryzen 5 5600XT.

The longevity of AM4 feels like it keys into a broader trend. Take the Nvidia RTX 4090 GPU. It has been replaced by the RTX 5090, but it's still very powerful, and I'd take it over the new RTX 5080. The 4090 will still be close to the top of the GPU performance tree for about the next four years.

Generational gains in performance from core PC components seem to have slowed. On one hand, it's disappointing when a new CPU or GPU doesn't blow away old chips. On the other, your PC stays current for longer.

AOC is taking aim at esports addicts with this ultra-quick 520Hz IPS 1080p panel.

Editor's Pick: AOC Agon Pro AG276FK

One for the esports enthusiasts out there

IF YOU'RE serious about esports, you want the highest refresh rate possible. This is where the new AOC Agon Pro AG276FK comes in. Running at 520Hz and sporting an IPS panel with 0.5ms GTG response, it's up there among the fastest LCD-based gaming monitors you can buy.

If there's a catch, it's that the native resolution is 1080p. Purely for playing online shooters, that makes sense in terms of minimizing GPU load and maximizing frame rates. However, for other types of gaming, the low pixel density of 1080p on a 27-inch monitor like this isn't ideal.

That lofty refresh rate makes for a pricey panel for a mere 1080p model. So, the AOC Agon Pro AG276FK really challenges you on just how dedicated to the cause of esports you really are. This is never going to be a great all-rounder.

At least the pricing translates into a high-quality stand with a full range of adjustment, including height, tilt, pivot, and swivel. It's well built, the materials feel high quality, and the design includes some quirky asymmetric features. The slim bezels on three sides of the 27-inch IPS panel also ensure it looks current.

As for connectivity, you get two DisplayPort 1.4 connections capable of the full 520Hz. The two HDMI 2.0 sockets only go to 240Hz, but they're aimed at console connectivity, and that only requires 120Hz at most. The ports are all on the bottom of the chassis, while a slide-out headphone hanger is situated on the right-hand bezel.

If speed is what the AOC Agon Pro AG276FK is all about, it delivers. The highlight is that 520Hz refresh. Up around 500fps in the few shooters in which you can achieve that with a high-end GPU, then, this monitor flies. Obviously, the gains are marginal as you increase refresh rates, but you can certainly feel the reduction in latency and see the increase in motion clarity compared to, say, a 144Hz panel.

Put it next to a 360Hz monitor, and the gains will be more marginal. Ultimately, the extent to which you notice and benefit from 520Hz will always be subjective. But if ultra-low latency is something you think you're particularly sensitive to—well, this AOC gets the job done and then some.

It's also fast for an LCD panel when it comes to pixel response. You can choose between the four levels of pixel overdrive in the OSD menu. A touch of overshoot can be detected in the fastest mode when jiggling an app window around. But in-game, there's little evidence of the kind of color shift that can be so distracting. You'll need to make the jump to an OLED panel to get something clearly faster.

Another strong point is calibration. It's nicely set up in SDR mode, with punchy and accurate colors. This panel doesn't have local dimming, so isn't a true HDR screen, but the HDR mode is still nicely executed, and that includes accurate SDR colors.

If that sounds good, the major downside involves pixel density. 1080p stretched across a 27-inch panel like this makes for a lowly density of 82DPI. That translates into blocky image quality and rough-looking fonts. For general computing, web browsing, or content creation, this is not a great display. But that is not its remit.

Arguably the bigger problem is the lack of image detail in-game versus, say, a 27-inch 1440p panel. For gaming across a wide range of genres, a 240Hz 1440p panel would be a better fit. But as an esports panel, this AOC delivers—you just have to be sure that's what you're after. **–JL**

$550, www.aoc.com

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Nvidia GeForce RTX 5090

The fastest GPU around, but not the huge leap we'd hoped for

THERE'S AN ALTERNATIVE 2025 where you get the Nvidia RTX 5090 of your dreams. That's a timeline where Nvidia has chosen TSMC's most advanced process nodes, managed to negotiate an unprecedented deal on silicon production, and worked some magic to deliver the same sort of generational rendering performance increases we've become used to since the RTX prefix was born.

That would be a 2025 where Nvidia hasn't slapped a $400 price hike on the most powerful of its new RTX Blackwell graphics cards. But in this timeline, the RTX 5090 is an ultra-enthusiast graphics card that doesn't quite deliver, thanks to the harsh realities of chip production and Nvidia's unwillingness to really pull out the stops.

For the RTX 5090, Nvidia has carried over essentially the same TSMC production tech as the outgoing 4090. Had it gone with the most advanced process node available, and thus even more performance-enhancing CUDA cores, the assumption is that the RTX 5090 would have been even more expensive.

But that didn't happen, so Nvidia is leaning heavily into software and AI features this generation. Nvidia claims the 5090 is a GPU designed for a future of AI processing. That doesn't mean it's good at generating pictures of astronauts riding horses on the surface of the moon, though it undoubtedly can do that. Rather, AI processing is built into its core design, and is how you get a substantial gaming performance boost versus older GPUs.

That's because on paper, the 5090 is only about 30 percent more performant than the RTX 4090. It's got around 30 percent more CUDA cores, and performs about 30 percent better in standard raster and ray-traced rendering. Actually, the latter is a bit of a disappointment, given Nvidia claims to have overhauled the RT cores.

Of course, even a 30 percent boost means it's easily the fastest GPU on the planet for raw performance. It's just the outgoing RTX 4090 managed a much larger 60 to 70 percent boost over the RTX 3090. Again, it's that lack of more advanced silicon preventing a really big generational step.

STANDING APART

Consequently, it's the AI stuff that really marks the 5090 out. For the first time, the programmable shaders or CUDA cores have been given direct access to the AI-accelerating Tensor Cores, allowing for what Nvidia is calling Neural Shaders and features like neural texture compression.

How much impact that will have in the long term is hard to say. However, what the 5090 delivers is a new version of Nvidia's DLSS scaling technology. In part, DLSS 4 is available to previous generations of Nvidia GPUs. That includes the change from a convolutional neural network to a transformer AI model for the upscaling, which delivers some very welcome improvements in image quality.

But arguably and above all other features, it's Multi Frame Generation (MFG) that marks out all of the new RTX 50 generation GPUs in terms of DLSS functionality. Long story short, RTX 50 GPUs can insert up to three AI-generated frames in between fully rendered frames, as opposed to just one for previous generations of RTX cards.

The result is a huge jump in frame rates when enabled. Of course, like all frame generation technologies, it doesn't improve latency. Indeed, it actually adds to latency, albeit by an impressively tiny amount of about 5ms at worst. What you get is smoother rendering, but not more responsive gameplay.

Still, seeing the likes of *Cyberpunk 2077* running in full path tracing mode at 4K and achieving over 200fps, thanks to a combination of DLSS upscaling, and MFG is a sight to behold. It's not quite the same as 200-plus frames per second achieved with conventional rendering, but it's still impressive, and something the old 4090 simply can't match.

As it happens, the last word really has to go to that old RTX 4090 GPU. Arguably, what the new $1,999 5090 does more than anything else is underline what a great deal the 4090 was for $1,600. Not every new high-end GPU is a huge step forward. The RTX 4090 certainly was. The 5090? Not quite so much.
–DAVE JAMES & JEREMY LAIRD

VERDICT
7

Nvidia GeForce RTX 5090

+ ARTIFICIAL INTELLIGENCE The fastest GPU there is; Incredible engineering.

− A BIT ARTIFICIAL Frame generation aside, the generational gains are fairly modest.

$1,999 www.nvidia.com

BENCHMARKS

	Nvidia Geforce RTX 5090	Nvidia Geforce RTX 4090	Nvidia Geforce RTX 3090
Black Myth Wukong 4K High (fps)	**82**	64	37
Cyberpunk 2077 4K RT Ultra (fps)	**58**	45	22
F1 24 4K RT Ultra (fps)	**110**	81	41
Homeworld 3 4K Epic (fps)	**111**	102	69
Talos Principle 2 4K Ultra (fps)	**79**	63	35
Warhammer III 4K Ultra (fps)	**101**	72	44

Best scores are in bold.

SPECIFICATIONS

CUDA cores	21,760
Boost clock (GHz)	2.41
Tensor core TOPS	3352
Ray tracing core TFLOPS	318
Memory	32 GB GDDR7
Memory bus width	512-bit
Total Graphics Power (watts)	575
Power connector	1x 600 W PCIe Gen 5 OR 4x PCIe 8-pin adapter

Impressive: Nvidia has engineered the new RTX 5090 Founders Edition as a mere dual-slot card.

Lenovo Legion Tower 5i (Gen8)

A great entry-level gaming PC and a solid buy for 1080p

LENOVO ISN'T MESSING AROUND with its Legion gaming PCs. They are resolutely, uncompromisingly, just PCs. Sure, there's the faintest nod to 'gamer' styling with the RGB-illuminated front panel and see-through side, but the Legion Tower 5i is, without wanting to sound at all mean, pretty basic.

I think it's grand. I'm all for that when it comes to affordable gaming PCs; I don't want to see money wasted on needless luxuries when I'm chasing down a good budget rig. The CPU cooler is a no-name brand, there are no VRM heatsinks or SSD-cooling plates on the barebones motherboard, and the memory sticks are bare PCBs.

The OEM Nvidia RTX 4060 graphics card is similarly simple, but beautifully so. I'm into miniature cards where they make sense, and the low-end Ada Lovelace GPU is so efficient that it doesn't need a massive dual-slot, triple-fan cooling array to keep it running to full effect.

Thankfully, at this level, we have components smart and efficient enough that they don't overly tax the cooling options available, so there's no fan noise or overheating to complain about. Neither the CPU or GPU go beyond the 76 C mark under heavy gaming loads, and while the Intel processor will hit 95 C when all its cores are being hit at 100 percent processing load, that's actually entirely standard.

Lenovo has gone for the Core i5 14400F, a ten-core, 16-thread Raptor Lake Refresh chip that's arguably one of the best budget CPUs around. It's no productivity beast, I'll be honest. Despite that effective ten-core labeling, what you're getting are actually just six Hyperthreaded Performance cores, with a further four Efficient cores for lighter workloads. But for gaming, those P-cores are the important factor, and are more than capable of delivering data to the GPU in a speedy enough manner to keep the frames rolling.

That GPU is the budget-focused RTX 4060. It's the lowest-spec graphics card in the RTX 40-series, but it's an effective enough 1080p gaming GPU. Alongside that well-balanced CPU/GPU combo, Lenovo has dropped in a 1TB Samsung PCIe 4.0 SSD (and a pretty speedy one, too) plus 16 GB of DDR5 memory. Sadly, that bare memory is running at 4400 MT/s, but as this isn't exactly designed as a workstation beast, that slow RAM isn't going to be a real hindrance.

So, how does it actually perform? Well, you can see why they call the RTX 4060 a 1080p GPU, and even with the panacea of Nvidia's upscaling and interpolation, I wouldn't recommend this Legion Tower 5i as anything other than a 1080p gaming PC.

When I first received this machine for testing, it was on offer for $850 at Best Buy, and had been for a number of months, but despite there still being quite a few PC deals around at the moment, the cheapest this rig is on offer for at time of writing is $900 at Lenovo's own store.

The simple setup means it's an easy system to upgrade. There's a spare M.2 slot, and clearance isn't a problem if you wanted to go for higher-spec memory. The only issue is that the OEM B660M motherboard is very basic, even down to the BIOS, which might cause some problems trying to get XMP running on speedy RAM kits. It's also only got a handful of USB sockets, and a solitary Type-C connection on the back panel.

The other sticking point would be that 500W PSU. Realistically, if you wanted a big GPU upgrade, you'd need a new PSU alongside it. Thankfully, the PSU inside the Legion Tower 5i is entirely replaceable, too.

All in all, it's a simple, effective, and well-built gaming PC that will see you right for 1080p gaming. The regular discounts make it an excellent budget machine, but competition is tough, and on any given day there could be a cheaper alternative on offer. **–DAVE JAMES**

BENCHMARKS

	Lenovo Legion Tower 5i (Gen8) (RTX 4060)	iBuyPower RDY Y40 Valorant VCTA R003 (RTX 4070 Super)	Velocity Micro Raptor ES40 (RTX 4070 Super)
3DMark Time Spy Extreme (Overall Index)	5054	9014	**9093**
Blender 4.2.0 Junkshop Rendering (GPU Score)	770	1483	**1503**
Cinebench 2024 Multi-Core CPU Rendering	784	1039	**1154**
Handbrake 1.8.1 UHD -1080p Transcode (fps)	52	80	**82**
7Zip Decompressing (GIPS)	80	**135**	131

Best scores are in bold.

VERDICT

8

Lenovo Legion Tower 5i (Gen8)

+ EIFFEL TOWER Standard PC parts; Runs cool and quiet; Clean, simple looks; Solid 1080p performance.

− TOWER OF TERROR 500W PSU is limiting; Needs those regular discounts to make this spec relevant; Only a single USB Type-C socket

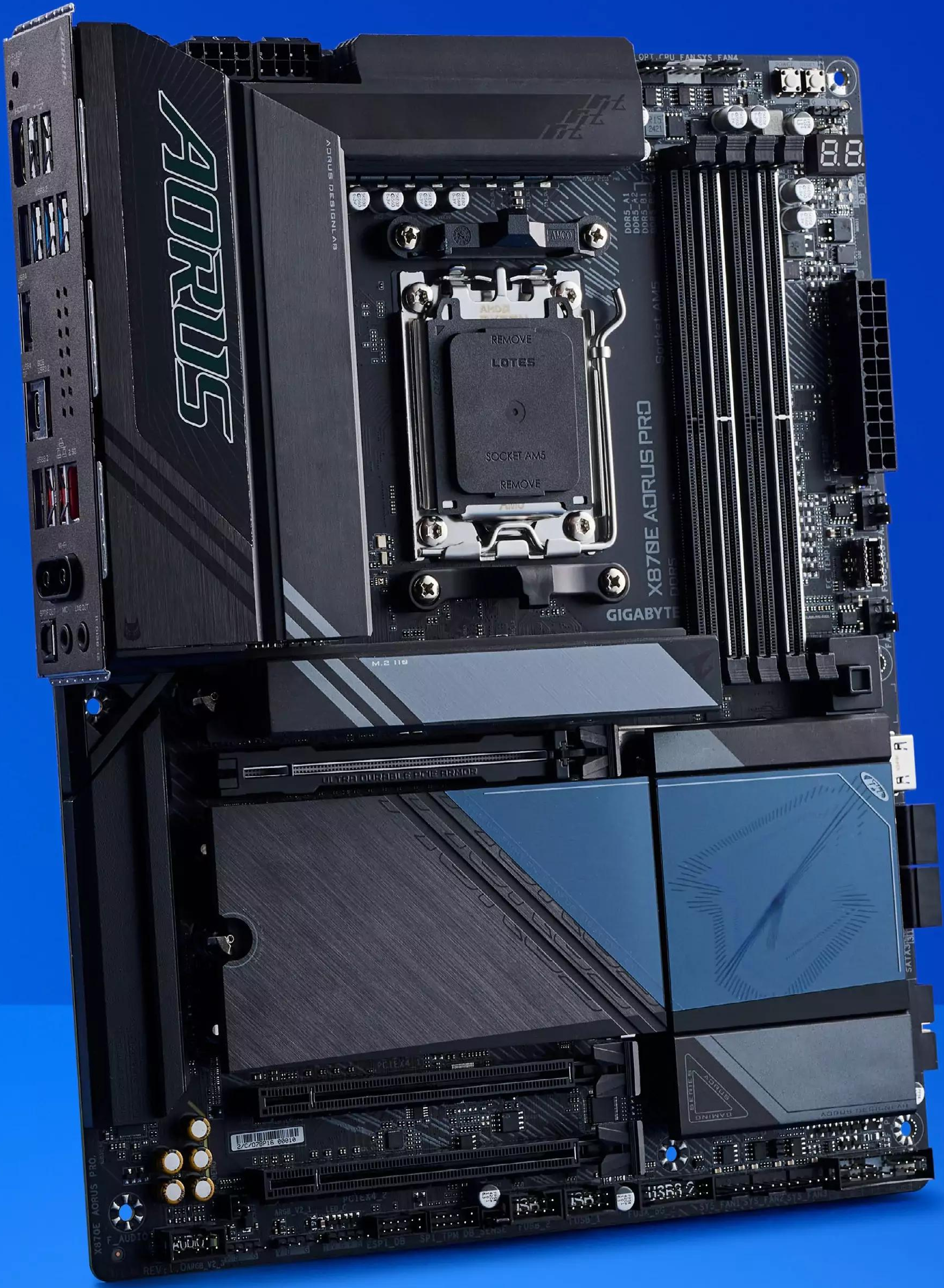
$900, www.lenovo.com

SPECIFICATIONS

CPU	Intel Core i5 14400F
Motherboard	OEM B660M
Memory	16 GB (2x 8 GB) DDR5-4400
GPU	Nvidia RTX 4060
Storage	1 TB Samsung PCIe 4.0 SSD
Warranty	1 year

LEGION
GEFORCE RTX 4060
LEGION
intel CORE i5
Lenovo

A no-frills gaming PC that does the basics well.



Gigabyte's new board is a high-spec X870E model at a very reasonable price.

Gigabyte X870E Aorus Pro

A user-friendly motherboard with a long life

THE GIGABYTE X870E Aorus Pro is not exactly cheap. But then, the X870E chipset is AMD's finest; the flagship choice. You get Wi-Fi 7, full PCIe 5.0 support across both graphics and some of the M.2 storage ports, USB 4 Type-C ports, plus features designed to make the building process as hassle-free as possible, as well as helping with hot-running PCIe 5.0 SSDs, and all for less than many premium motherboards.

It's the latter features that ultimately make the difference here given the older X670E chipset offers compatibility with the latest AMD CPUs and the same capabilities in terms of ports and bandwidth. At this price, you're also paying for premium looks and Gigabyte has delivered with a chunky set of dark, moody heatsinks for the M.2 ports and VRMs, as well as a dash of built-in RGB lighting above the I/O panel and chipset heatsink.

If you hate dealing with tiny M.2 screws or graphics cards stuck in their slots then you'll love the tool-free features on offer with the X870E Aorus Pro. They're easily as good as anything from Asus or MSI. The EZ-Latch feature applies to the M.2 SSD slots and heatsinks, plus the PCIe slot for your graphics card, with the former two benefitting from small latches that pop open with a finger press for easy removal and installation. To remove your graphics card there's a push-button next to the memory slots.

Even the Wi-Fi antenna gets the EZ treatment, with a combined connector that plugs into the I/O panel port, so there are no fiddly nuts or screws to deal with here, either. All of the four M.2 ports cool SSDs on both sides and three of them support PCIe 5.0 SSDs although the lower two PCIe 5.0 slots will steal bandwidth from your graphics card.

The rest of the PCB has nearly everything you could want, even for a high-end system. There are eight fan headers, a couple of 2-pin thermal probe headers if you're really going to town with your cooling, and you even get a POST LED display and power and reset buttons. It also has impressively large VRM heatsinks to cool the 16+2+2-phase power delivery.

Apart from the funky Wi-Fi connector, the rear I/O panel is a standard-looking affair that doesn't go all-out on USB Type-C like other boards have. Instead, you get two USB 4 Type-C ports and a total of nine USB Type-A ports comprising three USB 3.1, four USB 3.0 and two USB 2.0. Also on the I/O panel is a Q-Flash Button, otherwise known as BIOS Flashback, a 2.5 Gigabit Ethernet port and audio connectors for the Realtek ALC1220 codec.

Gigabyte's BIOS and software are pretty good, too, with the former offering a snazzy front page that makes it easy to get to the basic options such as memory EXPO/XMP and quick links to fan control and BIOS updating. The software is definitely useful for controlling your fans from within Windows, and its driver update utility also worked well, so should be handy for beginners.

If this was 2026 and AMD's Socket AM5 maybe only had another 12 months left, we'd suggest not spending this much on a motherboard that's likely got no upgrade path if you bought whatever Ryzen CPUs were around at that time, too. However, the Gigabyte X870E Aorus Pro will enjoy a decent lifespan with AMD previously promising to support the socket through to at least 2027.

Overall, this board has plenty to offer aside from future CPU support, as it has good VRM and M.2 cooling, looks fabulous, and is easy to work with, thanks to a bunch of tool-free features. It has limited RGB lighting as standard, and only two of the four M.2 slots are optimal, thanks to lane stealing. Other than that, it's a solid X870E board that's particularly user-friendly. **–ANTONY LEATHER**

VERDICT **8**

Gigabyte X870E Aorus Pro

+ BOARD WALK Good balance of ports; Easy to use; Everything poised for a high-end PC.

− WALK THE PLANK X670E is still tempting; Shared lanes between graphics slot and M.2 slots.

$359, www.gigabyte.com

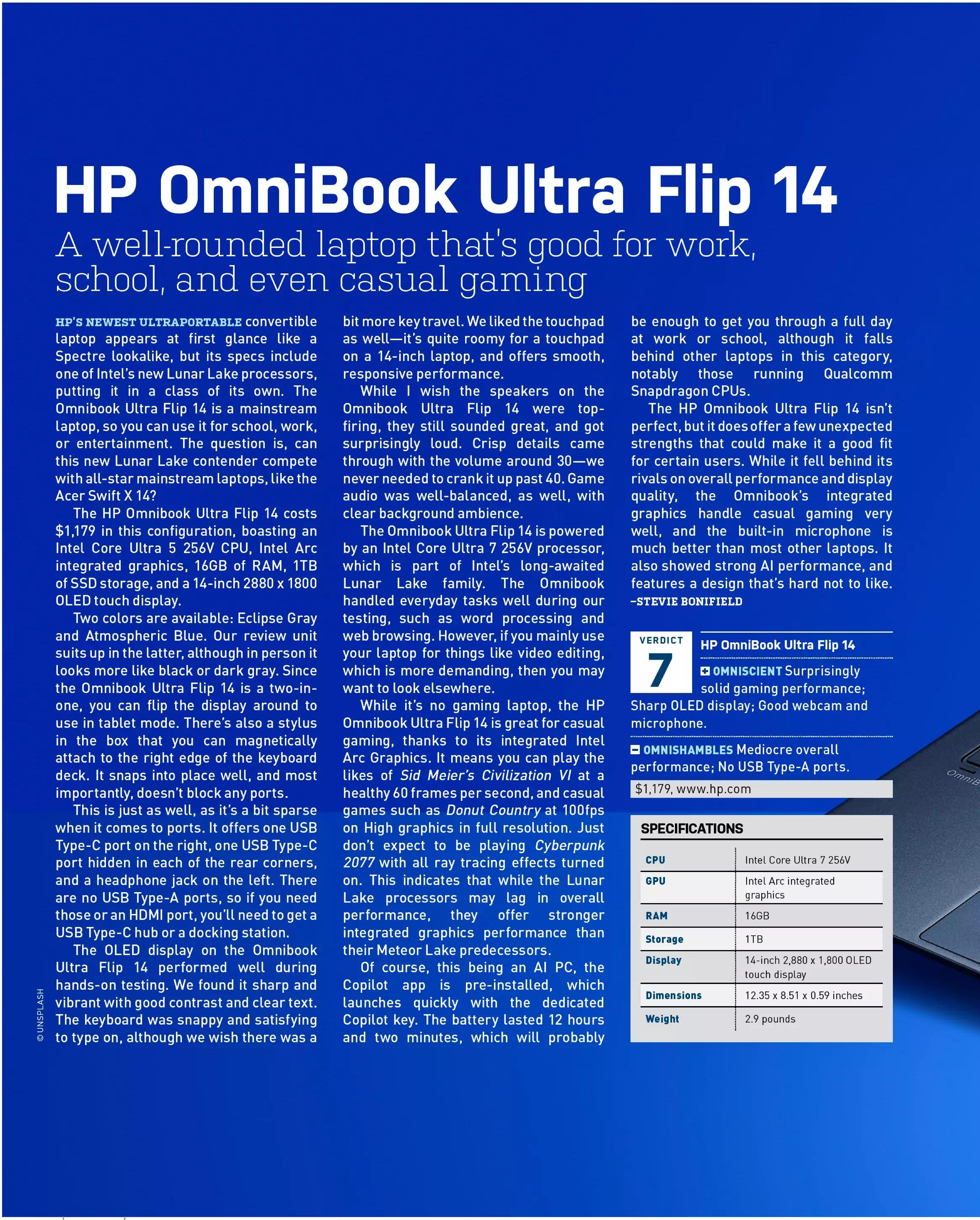
BENCHMARKS

	Gigabyte X870E Aorus Pro	Gigabyte X870 Aorus Elite WiFi7 Ice	MSI MAG X870 Tomahawk Wi-Fi
Cyberpunk 2077 (fps)	111	111	**117**
Baldur's Gate 3 (fps)	96	100	**103**
Gaming power draw (W)	112	**109**	114
Cinebench R24 multi-thread (pts)	1,786	**1,836**	1,820
Blender 4.2.0 (samples per minute)	147	**150**	**150**
Peak VRM temperature (C)	46	**44**	49
Peak SSD temp (C)	**66**	**66**	72

* All boards tested with an AMD Ryzen 9 9900X CPU and 32 GB Corsair Vengeance Pro DDR5-6000

SPECIFICATIONS

Socket	AMD Socket AM5
Chipset	AMD X870E
CPU compatibility	AMD Ryzen 7000/8000/9000 desktop
Form factor	ATX
Memory support	DDR5-4800 to DDR5-8200 (OC), up to 256 GB
Storage	4x M.2, 4x SATA
USB (rear)	2x USB 4 Type-C 40 Gbps, 3x USB 3.1 Type-A 10 Gbps, 4x USB 3.0 Type-A 5 Gbps, 2 x USB 2.0
Display	1x HDMI 2.1, 2x USB/ DisplayPort
Networking	Realtek 2.5G LAN, Wi-Fi 7
Audio	Realtek ALC1220



HP OmniBook Ultra Flip 14

A well-rounded laptop that's good for work, school, and even casual gaming

HP'S NEWEST ULTRAPORTABLE convertible laptop appears at first glance like a Spectre lookalike, but its specs include one of Intel's new Lunar Lake processors, putting it in a class of its own. The Omnibook Ultra Flip 14 is a mainstream laptop, so you can use it for school, work, or entertainment. The question is, can this new Lunar Lake contender compete with all-star mainstream laptops, like the Acer Swift X 14?

The HP Omnibook Ultra Flip 14 costs $1,179 in this configuration, boasting an Intel Core Ultra 5 256V CPU, Intel Arc integrated graphics, 16GB of RAM, 1TB of SSD storage, and a 14-inch 2880 x 1800 OLED touch display.

Two colors are available: Eclipse Gray and Atmospheric Blue. Our review unit suits up in the latter, although in person it looks more like black or dark gray. Since the Omnibook Ultra Flip 14 is a two-in-one, you can flip the display around to use in tablet mode. There's also a stylus in the box that you can magnetically attach to the right edge of the keyboard deck. It snaps into place well, and most importantly, doesn't block any ports.

This is just as well, as it's a bit sparse when it comes to ports. It offers one USB Type-C port on the right, one USB Type-C port hidden in each of the rear corners, and a headphone jack on the left. There are no USB Type-A ports, so if you need those or an HDMI port, you'll need to get a USB Type-C hub or a docking station.

The OLED display on the Omnibook Ultra Flip 14 performed well during hands-on testing. We found it sharp and vibrant with good contrast and clear text. The keyboard was snappy and satisfying to type on, although we wish there was a bit more key travel. We liked the touchpad as well—it's quite roomy for a touchpad on a 14-inch laptop, and offers smooth, responsive performance.

While I wish the speakers on the Omnibook Ultra Flip 14 were top-firing, they still sounded great, and got surprisingly loud. Crisp details came through with the volume around 30—we never needed to crank it up past 40. Game audio was well-balanced, as well, with clear background ambience.

The Omnibook Ultra Flip 14 is powered by an Intel Core Ultra 7 256V processor, which is part of Intel's long-awaited Lunar Lake family. The Omnibook handled everyday tasks well during our testing, such as word processing and web browsing. However, if you mainly use your laptop for things like video editing, which is more demanding, then you may want to look elsewhere.

While it's no gaming laptop, the HP Omnibook Ultra Flip 14 is great for casual gaming, thanks to its integrated Intel Arc Graphics. It means you can play the likes of *Sid Meier's Civilization VI* at a healthy 60 frames per second, and casual games such as *Donut Country* at 100fps on High graphics in full resolution. Just don't expect to be playing *Cyberpunk 2077* with all ray tracing effects turned on. This indicates that while the Lunar Lake processors may lag in overall performance, they offer stronger integrated graphics performance than their Meteor Lake predecessors.

Of course, this being an AI PC, the Copilot app is pre-installed, which launches quickly with the dedicated Copilot key. The battery lasted 12 hours and two minutes, which will probably be enough to get you through a full day at work or school, although it falls behind other laptops in this category, notably those running Qualcomm Snapdragon CPUs.

The HP Omnibook Ultra Flip 14 isn't perfect, but it does offer a few unexpected strengths that could make it a good fit for certain users. While it fell behind its rivals on overall performance and display quality, the Omnibook's integrated graphics handle casual gaming very well, and the built-in microphone is much better than most other laptops. It also showed strong AI performance, and features a design that's hard not to like.
–STEVIE BONIFIELD

VERDICT
7

HP OmniBook Ultra Flip 14

➕ **OMNISCIENT** Surprisingly solid gaming performance; Sharp OLED display; Good webcam and microphone.

➖ **OMNISHAMBLES** Mediocre overall performance; No USB Type-A ports.

$1,179, www.hp.com

SPECIFICATIONS

CPU	Intel Core Ultra 7 256V
GPU	Intel Arc integrated graphics
RAM	16GB
Storage	1TB
Display	14-inch 2,880 x 1,800 OLED touch display
Dimensions	12.35 x 8.51 x 0.59 inches
Weight	2.9 pounds

© UNSPLASH

This average performer still has a couple of surprising strengths.

ROG
25°07'28.3"N 121°28'17.3"E
FOR THOSE
ROG STRIX
WHO DARE
STRIX B850-F GAMING WIFI
ROG STRIX
PCIEX16(G5)
STRIX
GAME ON
GAME FIRST
WORK SECOND
PCIEX16(G4)

B850 is supposed to be a budget chipset, yet this costs $300.

Asus ROG Strix B850-F Gaming WiFi

AMD boards are too expensive. Fact

WE'VE WRITTEN extensively over these last few months about the slow creep of PC component pricing that's occurred over the last decade or so. It's been painful to watch, but if you take a look at the raw stats—certainly for CPUs and GPUs—it kind of lines up with inflation quite nicely (if not a little better, actually). In fact, most areas do, with one exception: motherboards.

This is the B850-F Gaming WiFi from Asus. It's a board built around AMD's new B850 chipset. In short, we've now got three distinct chipsets available for the 9th gen (and its AM5 socket predecessors). X870E is the crème de la crème, top dog. To hit that criteria and label, it needs a minimum of 44 PCIe lanes (24 of which are 5.0), two USB 5Gbps ports, 12 USB 10Gbps ports, and two USB 20Gbps, along with capacity to handle up to eight PCIe 3.0 or SATA ports. For X870E PCIe 5.0, USB 4 and overclocking capacity are absolutely mandatory.

Similarly, the X870 houses many of the same features, albeit manufacturers can get away with eight fewer PCIe lanes, one less USB 5Gbps port, six less 10Gbps ports, and one less 20Gbps port as standard (with four SATA drives).

Finally, because all of the above are ridiculously expensive, we have the newly launched B850. That keeps similar silicon to the X870, and touts the same 36 PCIe lanes, but now the boards only require support for four PCIe 5.0 lanes for an M.2 SSD, and its GPU only needs to be a single x16 PCIe 4.0 slot instead (yet it can be higher if the manufacturer wants it to be). And you still do get the same number of USB ports as found on the X870 line, although USB4 is classed as an optional extra, not a requirement. Following along? Yeah, us neither.

So how does pricing stacking up? For X870E boards, they range from $300 to $1,100. If you're looking at X870, it runs from $195 to $600. Finally, our new B850 boards land at $110 and go all the way up to around $350. For parity, Intel's Z890 chipset runs from $160 to $967.

Asus's B850-F sits at around $300, placing it high on the B850 stack, and it has really kitted the thing out. You still get that 256GB DDR5 @ 8,000 MT/s support; there's support for PCIe 5.0 GPUs, two PCIe 5.0 SSDs, along with four other M.2 drives as well. Flip around the back, and the I/O is as equally well equipped, with USB 10G ports, WiFi 7 2.5G Ethernet, and even a 20G port. Internal headers aren't exactly sparse, and it comes with a 16+2+2 VRM design to help with those overclocking attempts. Honestly, the thing is stacked, and it looks stellar, too.

Yet, that very much muddies the waters here. We have to ask, what's the point of all this? It's particularly problematic because even in Asus's own arsenal, you have boards like the X870-A Gaming WiFi, which is practically identical in terms of what it supports, bar one less USB-C port. Oh, and it's white and has 90A power phases versus the 80A on the B850, and comes in at $10 cheaper. And that's isolated to one manufacturer.

It's just a mess. Why on earth we're seeing boards that are so expensive, that lean into these chipsets, is beyond us. If you're going to take advantage of B850, then make it easy for the consumer; don't flood the market with multiple products that offer slightly different things at practically the same price point on two different chipsets. AMD, you're not helping by imposing minimum—but no maximum—requirements.

Is it good that we now finally have more affordable AM5 boards? Yes, it is; you can now pick up a respectable entry-level board for about $170. But the fact remains that until we get some true clarity across the chipsets, it still remains Ryzen 9th Gen's biggest weakness. As for the B850-F Gaming WiFi, it's a seriously good motherboard; it's just on the wrong chipset. **–ZAK STOREY**

VERDICT

9

Asus ROG Strix B850-F Gaming WiFi

+ HOME RUN Phenomenal connectivity; Solid power delivery; Strong overall design; Respectable price point; Smart M.2 heatsink latch solution.

− STRIKING OUT Confusing market position; Lacks USB4; AMD chipsets are a mess.

$300, www.asus.com

SPECIFICATIONS

Chipset/Socket	B850 / AM5
Max Memory Support	256GB DDR5 @ 8000+
Storage Support	4x M.2 Slots (2x 5.0x4 and 2x 4.0x4), 2x SATA 6Gb/s
PCIe Support	1x PCIe 5.0 x16, 1x PCIe 4.0 x16
Form Factor	ATX, 12 x 9.6 inches
Rear I/O	1 x USB 20G Type-C, 2 x USB 10G Type-A, 1 x USB 10G Type-C, 4 x USB 5G Type-A, 4 x USB 2.0 Type-A, DisplayPort, HDMI, WiFi 7, 2.5G Ethernet, 2x Audio jacks, Optical S/PDIF out port, BIOS FlashBack, Clear CMOS

OneXPlayer OneXFly F1 Pro

The first AMD Strix Point-powered über handheld

BEHOLD the first gaming handheld PC we've used that sports AMD's latest APU, the Ryzen AI 9 HX 370—the chip formerly known as Strix Point. It's a game-changer for handhelds. It brings Radeon Anti-Lag and Fluid Motion Frames 2, the latter being AMD's frame-generation technology. Those APU-enabled features are what set the OneXFly F1 Pro apart.

Mind you, that $1,339 price tag sets it apart, too. That money would get you a full RTX 4070 Super gaming PC, and leave enough change for a decent 1080p gaming monitor. So yeah, you've got to really want that ultra-compact form factor.

However, what you are getting is a stellar gaming device with performance

ONEXPLAYER

It's a familiar design, but OneXPlayer has given its premium handheld an internal upgrade.

to match its aesthetics. The slightly rubberized texture and smooth curves of the chassis feel great. While it's relatively weighty—around 600g—its ergonomics and balance make it feel like one of the best-designed handhelds I've ever used.

If the physical design is created for the gaming long haul, sadly that does not extend to the OneXFly's battery. The 48.5Wh battery is far too small to deliver a convincing long-term gaming experience with the OneXFly, and rarely survives beyond an hour and 40 minutes.

Still, the good news is that the Ryzen AI 9 HX 370 chip absolutely flies inside a handheld. The level of gaming performance running at just 15W is pretty jaw-dropping. Sure, that's only made real by the twin pillars of upscaling and frame generation, but being able to hit between 43 and 52fps in *Star Wars: Outlaws* at an upscaled 1080p resolution feels great.

Running at the same 15W level with the same settings, the original OneXFly F1—with its Ryzen 7 7840U APU—is only capable of knocking around the low 20s in the fps stakes. However, that sort of performance delta looked unlikely when I was first doing my comparative testing against the older Ryzen APU.

Most of our gaming performance numbers show just a handful of fps between them. The same is true when you start throwing in upscaling. That changes when you enable frame generation in any form. There's instantly a bigger performance delta, especially so when reducing the power available to the APU.

While that new AMD chip is one of the main reasons I'm so smitten with the OneXPlayer F1 Pro, it's not the only one. The 7-inch 144Hz OLED panel is also a beauty. Running at 50 percent brightness, it has plenty of punch, but maxed out, it hits an eye-popping 800 nits. The contrast is obviously exquisite, but the colors also sing, and both the refresh and OLED response time make gaming feel great.

This is the 32GB RAM and 1TB SSD version, so it makes for a good all-round PC, too. You get two USB4 Type-C connections and a full-size USB 3.0 Type-A port on top, so you could happily dock this to a monitor and have a fully functional PC.

The F1 Pro likewise has all the configurable physical buttons you could want. The OneXConsole application has matured a lot, and while it's still not as user-friendly as the Ayaneo software, it's got all the functionality, especially now there are performance profiles you can make and switch to on the fly.

It's also a size that delights. I liked the Ayaneo Kun for its big screen and extra touchpads, but it's a lump to lug about. With the OneXFly, it's just the size of that 7-inch OLED screen and the pads. The bezels are slim, and the device relatively diminutive. Color me a big fan. It's one of the best handheld gaming PCs I've used, combining functionality with form and performance. **-DAVE JAMES**

EVANGELION
Y
X
B
A
EMERGENCY

BENCHMARKS

1080p gaming with upscaling	OneXPlayer OneXFly F1 Pro | AMD Ryzen AI HX 370	Zotac Zone AMD Ryzen 7 8840U	Ayaneo Flip DS AMD Ryzen 7 8840U
Cyberpunk 2077 (fps)	**47**	42	38
Black Myth Wukong (fps)	**34**	30	29
F1 24 (fps)	**90**	81	62
Horizon Zero Dawn (fps)	**66**	62	60

Best scores are in bold.

VERDICT

9

OneXPlayer OneXFly F1 Pro

+ FLY MY PRETTY AMD's new APU is great for handhelds; 15W performance is stunning.

− BRUNDLE FLY Weak battery life; Expensive compared with Ally X and Steam Deck OLED.

$1,339, www.onexplayerstore.com

SPECIFICATIONS

APU	AMD Ryzen AI 9 HX 370
Cores	12
Threads	24
GPU	Radeon 890M
Compute Units	16
RAM	32GB LPDDR5X-7500
Storage	1TB Acer N7000
Battery	48.5Wh
Weight	599g

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CCleaner 6 Professional $14.95

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Another new feature of CCleaner 6 is the improved software updater. This helps to ensure that you always have the very latest versions installed.

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software.maximumpc.com

WD Black SN7100 1TB M.2 PCIe 4.0 SSD

Subtle change leads to one serious upgrade

WESTERN DIGITAL'S Black SN7100 is a bit of an oddity, as far as product launches go. It arrived with very little fanfare, and with good reason. On the surface, this absolutely muddies the waters when it comes to WD's PCIe 4.0 product stack. The problem child? The SN850X.

You can buy 1TB variants of both the SN850X and the SN7100 for exactly $85 right now. Identical capacity, extremely similar performance, and of course, the same brand, warranty, endurance ratings, security features, and more that you'd expect from a WD drive.

It's only when you dig under the surface that you start to get a feel of why the SN7100 was launched and what it represents. In short, this is a bit of a subtle update on the SN850X, but more from a manufacturer's point of view than an enthusiast's. It's being positioned like the 850X's direct, inevitable replacement.

Why the sudden change? Well, the SN850X is, at this point, well over two years old. In its 1-4TB configurations, it features 112-Layer Kioxia BiCS5 TLC NAND, comes with a DDR4 cache, a double-sided design, and a proprietary controller. The SN7100, on the other hand, much like its SN5000 QLC cousin, has ditched the cache, and instead opted to run with just Kioxia's latest 162-layer BiCS6 TLC NAND instead. There's no DRAM on this thing, and that single-sided denser design gives it broader compatibility with consoles, laptops, and PCs alike, without compromising on the performance.

Not only does all of this reduce the manufacturing cost for WD, but with that more modern NAND and a tweaked controller (possibly), we're gifted with lower power draws and temperatures without sacrificing on the holy grail of SSD marketing: performance.

On paper, WD pegs the SN7100 as 7,250 MB/s on sustained read and 6,900 MB/s write. In our benchmarking, that pretty much lined up. CrystalDiskMark landed at 7,116 MB/s on the read and 6,820 MB/s on the write. Random 4K performance held up, with 276 MB/s on the write and 101 MB/s on the read.

Temperatures remained low, with a max recorded temp of just 48 C, dwarfing the likes of Samsung's latest 990 Evo Plus with its 59 C score, and it handled 3D Mark's SSD benchmark test admirably.

The SN7100 is a bit of a Frankenstein's monster in many ways. There's Kioxia's latest NAND, and potentially the same controller as the 4TB SN5000, all paired with a single-sided, more modern design. If you're after an affordable PCIe 4.0 SSD that remains cool and delivers some of the best performance we've seen at this capacity, form factor, and spec, the SN7100 is a true king. **–ZAK STOREY**

VERDICT
9

WD Black SN7100 1TB M.2 PCIe 4.0 SSD

➕ **SUPER NEAT** Impressively strong overall performance; Good temperatures; Solid pricing.

➖ **SIMPLY A NOBODY** Slightly lower random write speeds than we'd like.

$85, www.sandisk.com

SPECIFICATIONS

Variants	Stock
Form Factor	M.2 2280 (single-sided)
Interface / Protocol	PCIe 4.0 / NVMe
Flash Memory	Kioxia 162-Layer TLC
Sequential Read	7,250 MB/s
Sequential Write	6,900 MB/s
Endurance (TBW)	600
Warranty	Five years limited

BENCHMARKS

	1TB WD Black SN7100 PCIe 4.0 M.2 SSD	1TB Crucial P310 PCIe 4.0 M.2 SSD - 2280	4TB WD Blue SN5000 PCIe 4.0 M.2 SSD	1TB Samsung 990 Evo Plus PCIe 4.0 M.2 SSD
$ per GB	0.09	**0.07**	**0.07**	0.09
CrystalDiskMark 8 Sequential Read/Write - QD8T1 (MB/s)	**7,116 / 6,820**	7,109 / 6,035	5,511 / 5,054	7,081 / 6,238
CrystalDiskMark 8 Random 4K Read/Write - Q18T1 (MB/s)	**101** / 276	70 / **296**	79 / 296	68 / 232
Final Fantasy XIV Total Load Time (seconds)	7.841	7.305	**6.638**	8.044
3D Mark Storage Bench Score (Index)	**3,238**	2,999	2,915	2,980
3D Mark Storage Bench Bandwidth (MB/s)	**553.10**	517.77	502.43	508.26
3D Mark Storage Bench Access Time (ns)	**55**	60	63	61
Heatsink Used	Motherboard	Motherboard	Motherboard	Motherboard
Max Temperature (Celsius)	**48**	50	81	59

Best scores in bold. Our test bed consists of an AMD Ryzen 9 9900X, 64GB of Team Group T-Create @ 6,000, an Nvidia GeForce RTX 4080 Super, ASUS ROG Ryujin 360mm AIO, and an Asus ROG Strix X870E-E Gaming WiFi motherboard. Max temp recorded via HWMonitor during benchmark process. Prices correct at time of writing.

Asus ProArt PA602

Big, bulky, and beautifully built

IT'S NOT OFTEN that we get to take a look at a case like this one. Asus has designed its ProArt line with a very specific goal in mind. Traditionally, its monitors in particular were built around the needs and wants of designers and creative professionals, hence the name. They were highly calibrated products, with no frills or fuss, and they did an impeccable job of delivering absolute quality and consistency above all else.

With monitors, that makes sense; these are products that deliver color to your eyes, and having an accurate representation of what your client is going to see in print or online is pivotal.

It might seem like quite the contrary idea, then, to apply that same mantra and logic to case design. After all, a chassis exists, and is built in. Then, well, you're pretty much done with it. As long as the cooling functionality is solid and build quality adequate, nine times out of ten, that's that. This is certainly the case when it comes to industrial, professional, and creative use. So what is it that sets the PA602 so apart from that ideology? Does it really deserve that ProArt moniker?

Honestly, yes it does. It's a monster of a chassis, intuitively designed with all manner of features that appeal to professional and entry-level builder alike. Let's start with the cooling. The front dust panel comes with an IR dust detection sensor to help let you know when airflow starts to get restricted. Behind that lies massive twin 200mm fans acting as direct air intakes. The PSU shroud and internal cable tidy are specifically angled and shaped to direct airflow straight up to the GPU and CPU; that hot air is then exhausted by the included 140mm rear fan. The roof supports up to a 420mm AIO, and the entire cooling setup can be actively managed by an included PWM fan hub that can support up to six fan channels, all of which can be manually adjusted via the front I/O.

It's for the PC builders, though, where this case impresses the most. It has clearly been built to tease those doubters away from Apple and into the Windows and Linux ecosystems with a custom rig. You can tell. Everything is designed to make it easy to build in; cable management is provided with monumental velcro straps in the rear; there's support for a vast armada of SSDs and 3.5-inch drives (four 3.5 and eight 2.5); a cable tidy bar hides everything neatly; and all the panels are toolless. There's also an integrated GPU sag bracket and a toolless graphics card clamp solution, meaning you no longer have to mess around installing numerous screws to support the weight of an RTX 4090. It even has wheels so it can easily be moved around.

There's got to be a catch, right? Well, yes: it's not absolutely perfect. The wood effect located here and there does feel a little cheap—certainly a far cry from the brilliant walnut plates that Fractal has introduced lately—and the plastic elements do feel perhaps a little less premium than they ought to at this price.

Ah yes, the price. It's $255—that's a lot of cash for a case, no matter how good it is. That's $100 more than the likes of Lian Li's O11 Vision, $55 more than Hyte's Y70 chassis, and $15 more than NZXT's H9 Elite (although admittedly, that last one doesn't support E-ATX boards). All of these are phenomenal cases, delivering outstanding build quality, and as many, if not more, features than the PA602.

Still, this thing is something special. Unlike many big old PC boxes in the industry, it delivers on a premise that has been sorely missing for some time. It's a no-nonsense cooling monster with a design that epitomizes the ProArt ethos. It's consistent, dependable, and compatible, which is something that should be praised. **–ZAK STOREY**

VERDICT

9

Asus ProArt PA602

+ CLAUDE MONET'S COLLECTION Insane cooling; Impeccable feature set; Super-easy to build in; Highly compatible; Highly reliable.

− MY WARHAMMER COLLECTION Panel quality could be better; Pricing gives it stiff competition.

$255, www.asus.com

SPECIFICATIONS

Motherboard Support	ITX, Micro-ATX, ATX, E-ATX
2.5-inch / 3.5-inch Support	8x 2.5 / 4x 3.5-inch
Max Radiator Support	Up to 420mm Roof
Fan Support	3x 120/140mm Roof, 1x 120/140mm Rear (140mm included) 2x 200mm Front (200mm included)
Dimensions	23.3 x 9.6 x 22.0 inches
Graphics Card Clearance	17.71 inches
CPU Tower Clearance	7.48 inches

NZXT Kraken Elite 360

Monolithic design improvements

THERE ARE FEW coolers out there that are quite as synonymous as NZXT's Kraken line-up. Positively ancient now, the Kraken range has been around for well over a decade, initially launching all the way back in 2013. Since then, it has gone through revolution after revolution: from basic pump head to infinity mirror to full-on display. Now, we're graced with this majestic LCD beauty, with arguably one of the sleekest and well thought-out designs yet.

There's no beating around the bush here; this thing is wildly different to its predecessor. The pump-head by far sees the biggest change, gen on gen. First and foremost, NZXT has finally ditched the Asetek pump design, and opted for its own custom-built 'Turbine' solution instead. It has worked around Asetek's many, many patents to manage that. According to NZXT, this helps deliver an increased performance delta of around ten percent for CPU cooling, dependent on myriad circumstances, while reducing noise generation in the process. Still, that's a big change, and it's great to see manufacturers being able to iterate on designs and finally find ways to navigate around Asetek's giant trademark and litigation skirt.

The Kraken also has a slight upgrade in terms of display. Although the overall resolution and refresh rate remains 640x640 @ 60Hz, it has moved from a TFT-LCD to a full-on glossy IPS panel instead. That has increased the size from 2.36 inches all the way up to a whopping 2.72-inch display, the most obvious change with that being the far more refined bezel necessary to facilitate the larger size, and that too has impacted the overall bulk of the block as well. This thing is seriously big. With that bulky display, it clocks in with a diameter of 3.68 inches across, and it's 2.56 inches deep, too. Just wild. It fits, but it's a bit snug.

One of the necessities of that design is the removal of any data or power cables from that CPU block itself. NZXT has done this with its own proprietary 18-pin cable solution that now fits directly into the radiator itself; next to the tubing runs. This acts effectively as a breakout cable, going to one 3-pin connector for pump speed, a USB 2.0 cable for data transfer and software compatibility, one of NZXT's 8-pin fan connectors for its latest RGB Core frame fans (with one included with the AIO, dependent on the size and color you purchased), and a SATA power to keep everything running nice and smoothly.

This isn't the first time we've seen something like this in the market, but it is a massively welcome addition. Not only does it make cable management infinitely better, but it gives you a cleaner, tidier build around the motherboard's CPU socket. On top of that, it really does help with BTF builds, where the aim is to hide as many of those cables as possible. One of our biggest criticisms of our time with BTF was the fact that pretty much everything bar the AIO was cableless, so this is a big win if you're invested in that form factor. However, that does increase the depth on the radiator, as there's now a controller built into the rad itself, but it's honestly not that bad in most modern builds.

Rad shenanigans aside, this is a breeze to install and a beauty to run. It looks great, it's easy to configure, and with that simple, elegant design, it's a remarkable evolution over the last gen. If you're looking at a new premium build, and you've got the budget to stretch to something like the Kraken Elite, this needs to be on your shortlist. –ZAK STOREY

VERDICT
9
KICK ASS!

NZXT Kraken Elite 360

+ IT'S CRACKING! Insanely beautiful display; Outstanding compatibility; Intuitive pump design; Excellent cable management; Super quiet; RGB Core 'frame' fans.

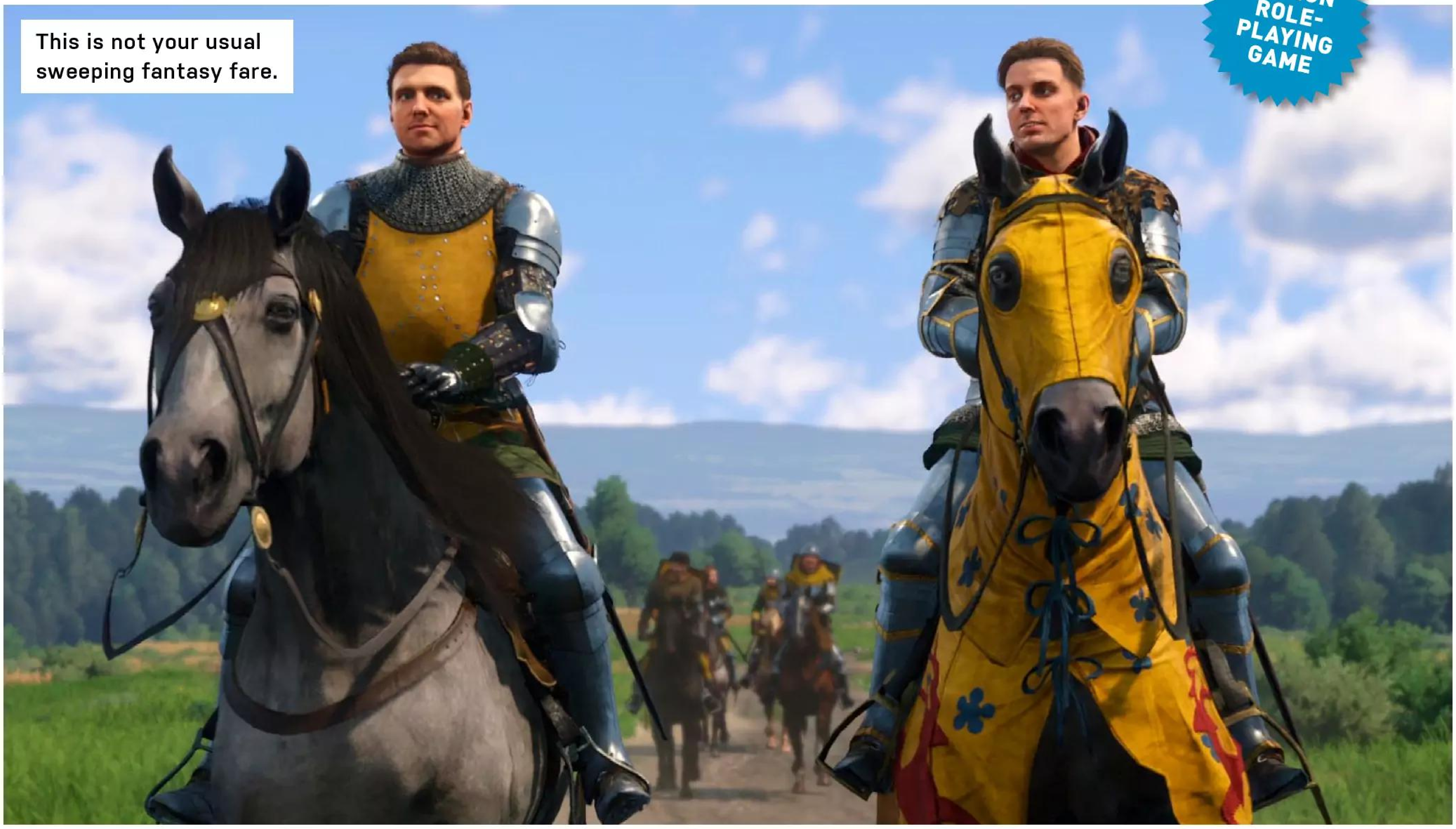
− IT'S CRACKING! Pricey; Block could be too large.

$320, www.nzxt.com

SPECIFICATIONS

Radiator Sizes Available	240, 280, 360 (360 Reviewed)
Colors Available	Black RGB, white RGB, black, white
Display	2.72-inch IPS LCD, 640x640 @ 60 Hz
Intel Sockets Supported	LGA 115X/1200, 1700, 1851
AMD Sockets Supported	AMD 4, AM5
Radiator Dimensions	15.78 x 4.72 x 1.06 inches
Tubing Length	16.53 inches
Fan Static Pressure	3.3 mmH2O
Fan Noise	30 dB(A)

ACTION ROLE-PLAYING GAME



This is not your usual sweeping fantasy fare.

Kingdom Come: Deliverance 2

Just as bizarre and ambitious as its inspirations

THIS MIGHT BE the most specific RPG we've ever played. Everything from its location to its era, combat, and clothing feels hyper-tuned and dialled in with precision to suit oddball tastes. If you're looking for a typically sweeping fantasy romp, you simply won't find one.

Like its predecessor, *Kingdom Come: Deliverance 2* is a game whose story springs inevitably from the politics of its time and place, namely Bohemia in 1403. Want to mow down your foes by the dozen? Good luck. Combat is a strange dance of positioning both your hands and feet relative to those of your enemies, and charging into the fray even in the late game is liable to get you cut apart. Want to equip a hauberk without first equipping a padded gambeson beneath it? What are you, some kind of moron?

KCD2 follows on directly from the first game. You're still Henry of Skalitz: blacksmith's son, noble bastard, orphaned when mercenaries attacked your town, and companion to Lord Hans Capon of Pirkstein. Bohemia is in the grip of war, torn between supporters of the abducted King Wenceslas of Bohemia and supporters of his abductor and brother, Sigismund.

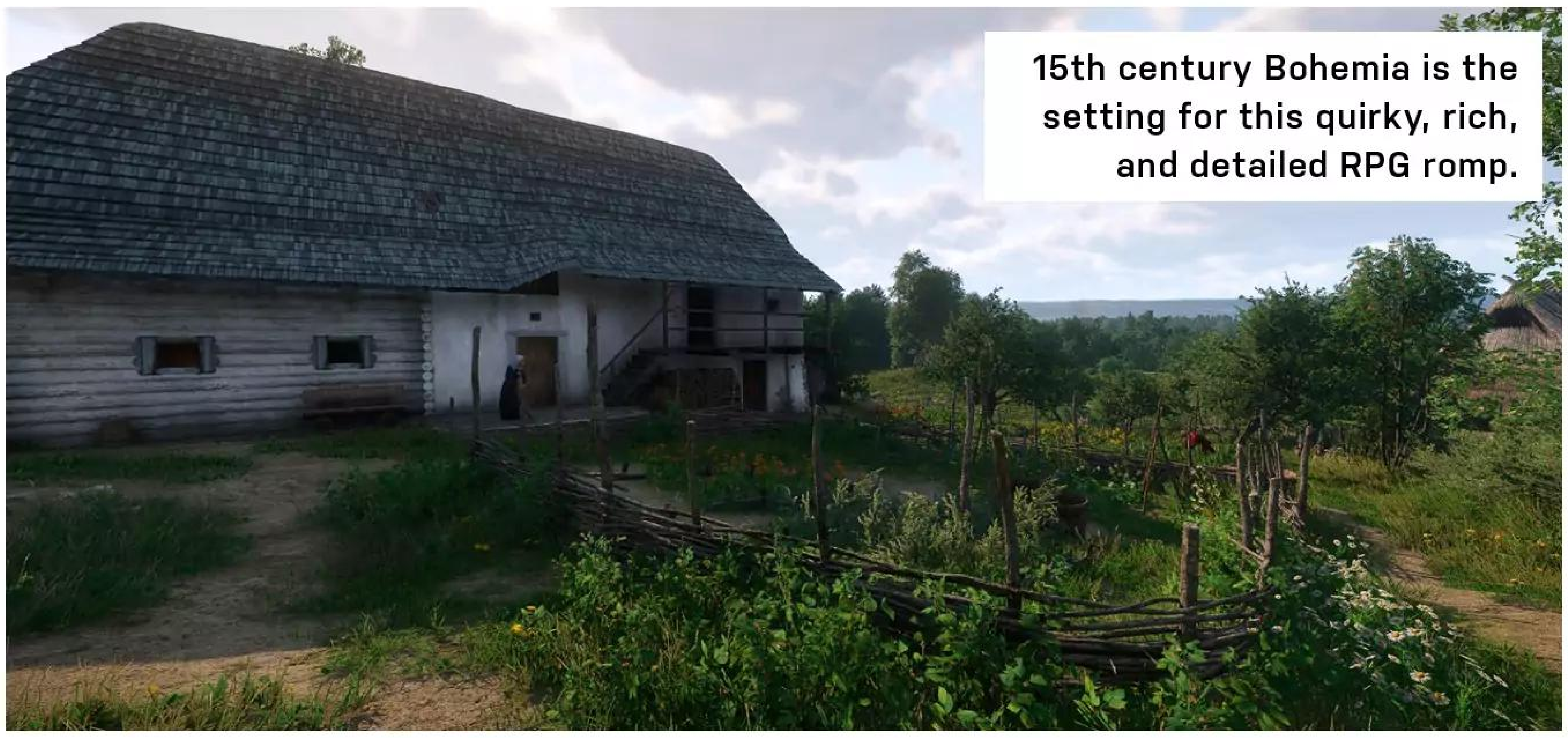
Capon's lordly guardians are Wenceslas supporters, and have dispatched him, Henry, and a retinue of protectors to deliver a letter to Otto von Bergow, one of the foremost supporters of Sigismund, with an eye to putting an end to the whole internecine thing. It all goes really, really well, and everyone gets to go home.

Oh no, wait, sorry, it all goes to hell pretty much immediately, and before long, Henry and Hans are AWOL on a quest that sees them jumping through all the mad loopholes and imbrications of 15th-century central European politics. All in all, it's great fodder for anyone who likes to sink their teeth into meaty political plots, and presents plenty of opportunities to chuck difficult choices and moral compromises at you.

It's the game's systemic ambitions that really elevate it, though. There are times when Warhorse's simulation of a medieval world approaches *Stalker*-levels of zeal. Stole something from a house without being spotted? If someone spied you hanging around there, they'll still put two and two together and report you to the guards. I once got chased out of a fortress because I'd absent-mindedly equipped a stolen ring and walked past the schmuck I took it from.

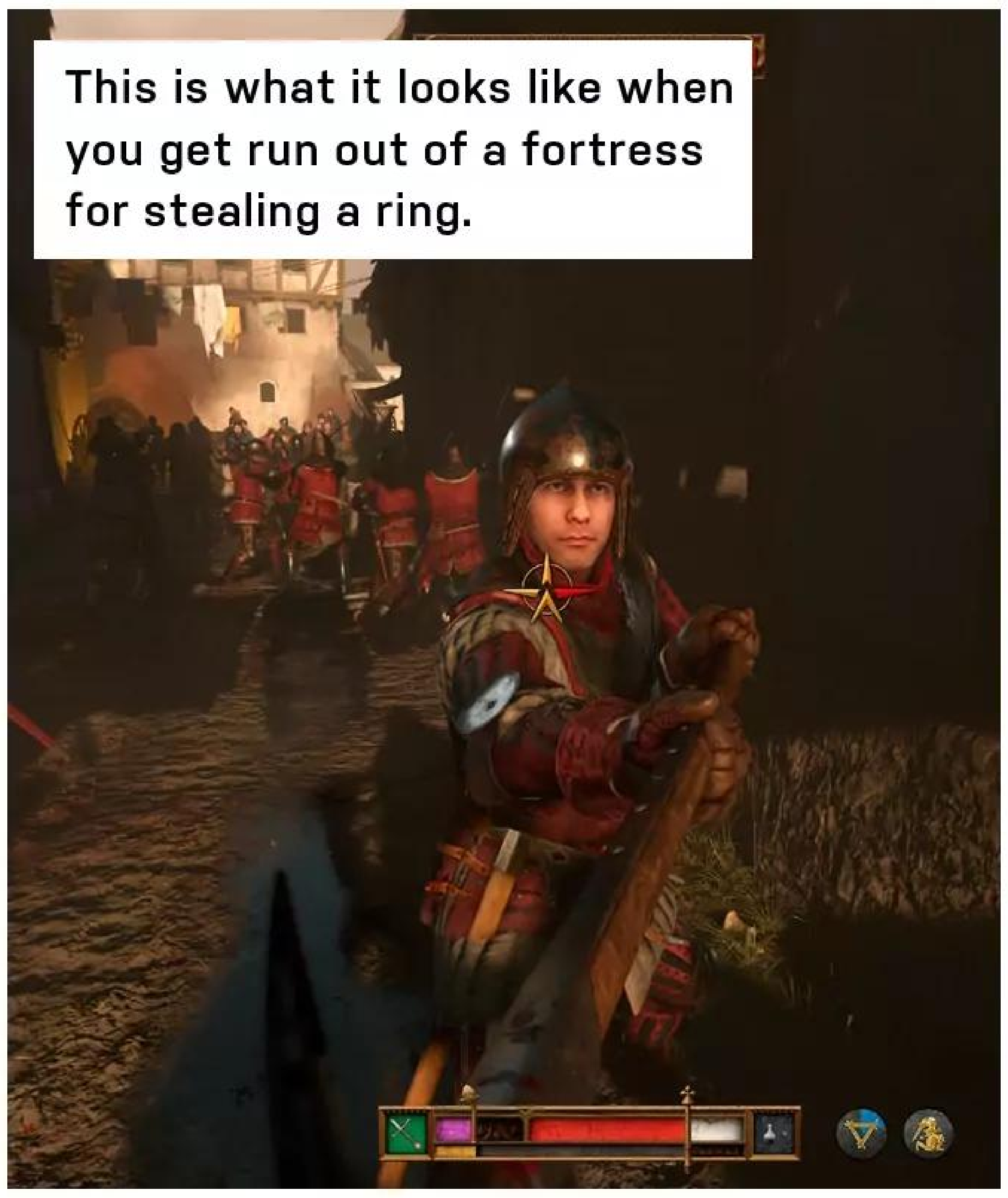
It's that kind of world; a world of rules, that feels interested in itself for its own sake, and feels to some extent like it happens independent of you. By the end, when you're teeming with perks and fancy gear, you'll be a rambling Bohemian Cuisinart turning all your foes to shreds, but even this feels like a more earned and systems-driven process than in your average *Skyrim*-inspired RPG. You're not just inevitably climbing a leveling power curve; you're feeling out the edges of the game—what's possible, impossible, and expected from you.

Even over its ample runtime, *KCD2* manages to maintain a sense of momentum and unfurling between all its stuff to do and the zigs and zags of its plot. You're a soldier, then a spy, then a gambler, then a blacksmith. The arc of its medieval life simulator is long and varied. About 50 hours in, the game suddenly

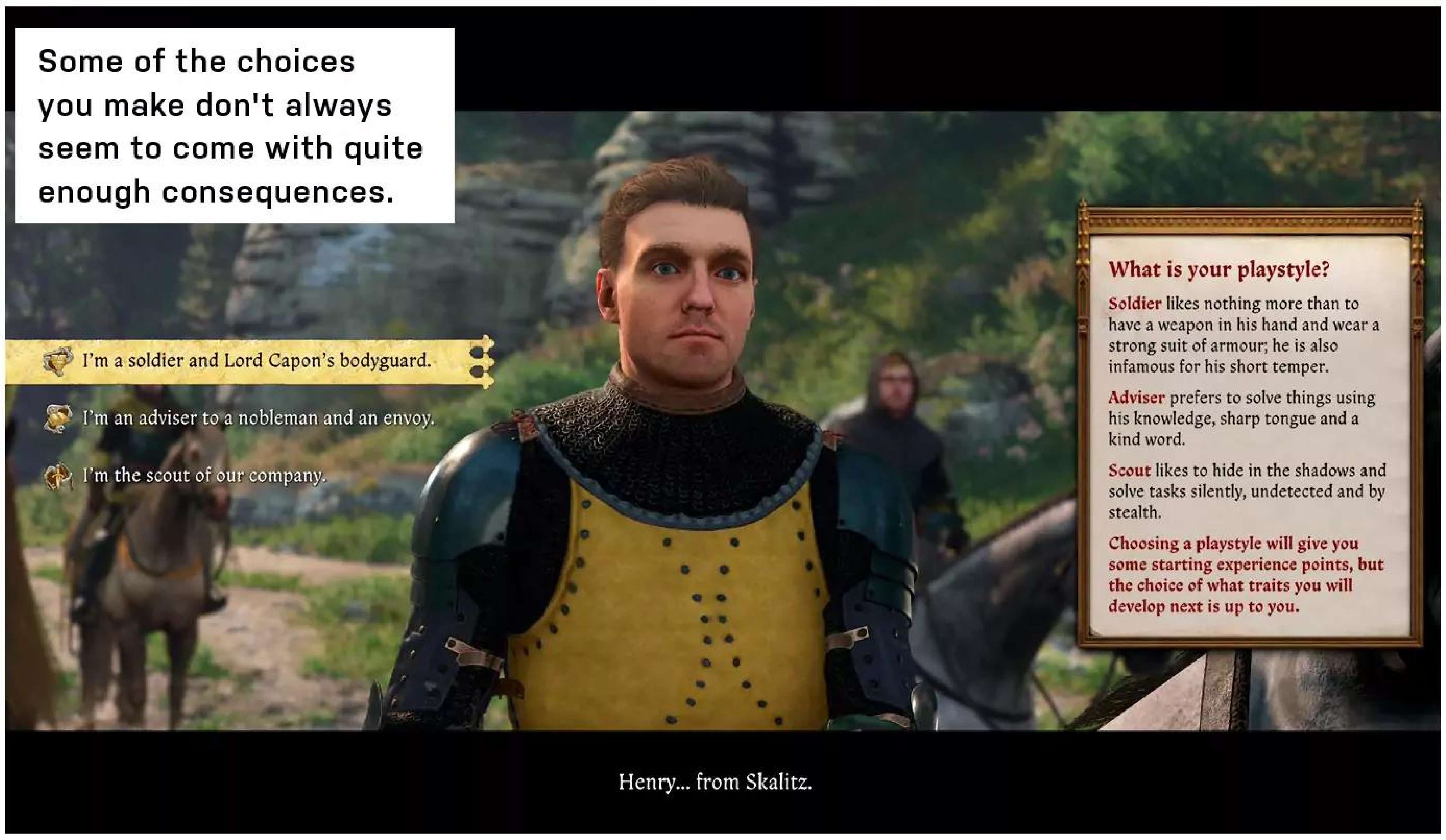


15th century Bohemia is the setting for this quirky, rich, and detailed RPG romp.

It's hard to avoid becoming immersed in this world.



This is what it looks like when you get run out of a fortress for stealing a ring.



Some of the choices you make don't always seem to come with quite enough consequences.

I'm a soldier and Lord Capon's bodyguard.

I'm an adviser to a nobleman and an envoy.

I'm the scout of our company.

What is your playstyle?

Soldier likes nothing more than to have a weapon in his hand and wear a strong suit of armour; he is also infamous for his short temper.

Adviser prefers to solve things using his knowledge, sharp tongue and a kind word.

Scout likes to hide in the shadows and solve tasks silently, undetected and by stealth.

Choosing a playstyle will give you some starting experience points, but the choice of what traits you will develop next is up to you.

Henry... from Skalitz.

sprung a whole Thieves' Guild questline on me to finally make use of those stealth skills I'd been underusing for the rest of my playthrough.

All of this means *KCD2* feels a bit miraculous—a ludicrously ambitious and peculiar thing that somehow fulfils its ambition, managing to hit the highs Warhorse aimed for in the first game, but fell just short of. It feels tailor-made for a certain brand of systems-loving sicko—the kind of person who still gets starry-eyed about *Stalker* and *Morrowind*—and manages to actually make good on their nostalgic yearning for those halcyon games of old. –**JOSHUA WOLENS**

VERDICT
9

Kingdom Come: Deliverance 2

➕ **A KNIGHT'S TALE** Consistently quirky; Hugely varied and detailed; Sweeping story arc.

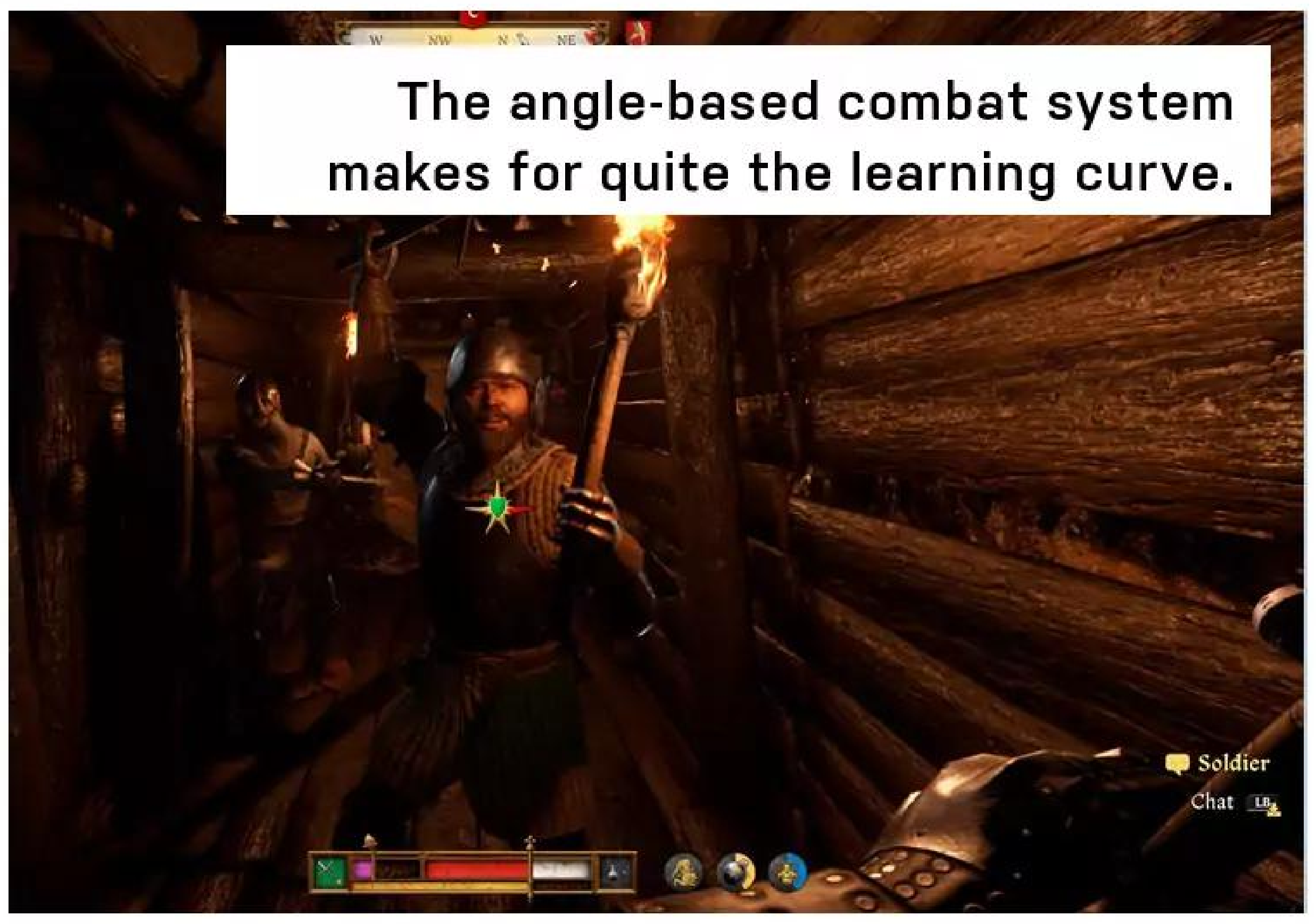
➖ **SOMETHING OF THE NIGHT** Some of your in-game decisions lack narrative consequence.

RECOMMENDED SPECS CPU, Intel Core i7-13700K, AMD Ryzen 7 7800X3D. GPU, NVIDIA GeForce RTX 4070, AMD Radeon RX 7800 XT. RAM, 32GB. OS, Windows 10.

$59.99, www.kingdomcomerpg.com, M-rated

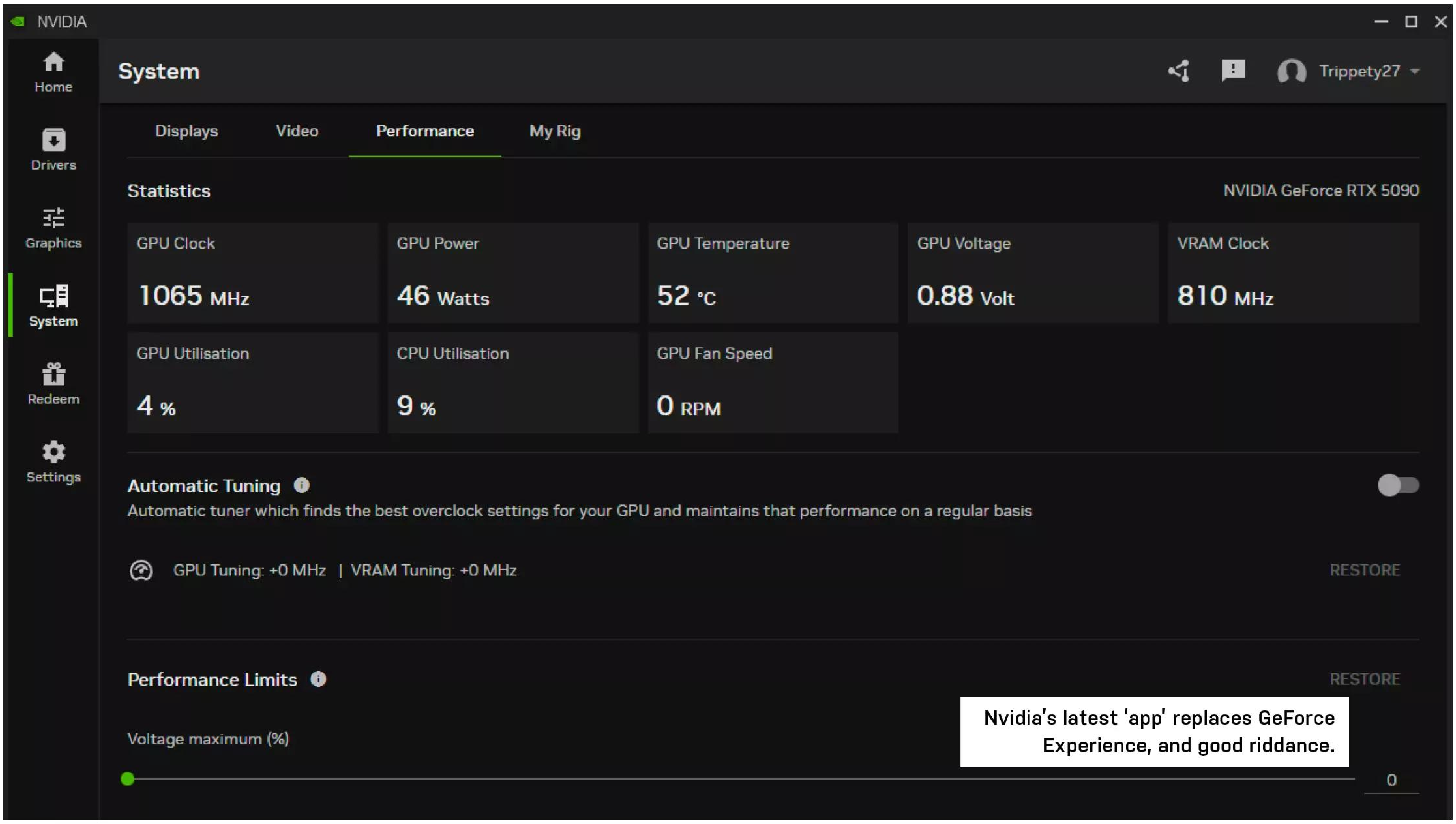
© DEEP SILVER

By the end of the game, you'll be a rambling Bohemian Cuisinart, tearing all your foes to shreds.



The angle-based combat system makes for quite the learning curve.

'Ambition' is very much the byword here.



System

Statistics — NVIDIA GeForce RTX 5090

GPU Clock: 1065 MHz
GPU Power: 46 Watts
GPU Temperature: 52 °C
GPU Voltage: 0.88 Volt
VRAM Clock: 810 MHz
GPU Utilisation: 4 %
CPU Utilisation: 9 %
GPU Fan Speed: 0 RPM

Automatic Tuning
Automatic tuner which finds the best overclock settings for your GPU and maintains that performance on a regular basis

GPU Tuning: +0 MHz | VRAM Tuning: +0 MHz

Performance Limits

Voltage maximum (%): 0

Nvidia's latest 'app' replaces GeForce Experience, and good riddance.

© NVIDIA

NVIDIA App vs AMD Software: Adrenalin Edition

GPU software heats up

THIS IS A bit of a weird one for us. We're actually going to do a two-parter 'Software Versus'. Yep, you heard right. Initially, it was going to be a three-way battle between Nvidia, AMD, and Intel as to who had the greater graphics card program in the modern era, but because we didn't want to give the Art team an aneurysm redesigning the layout for one issue, we figured it would be better to run one part of this issue, then pit the winner against the other in the next.

What's all the fuss, then? Basically, Nvidia recently decommissioned GeForce Experience and launched a new entirely rebuilt replacement of the thing in the form of the imaginatively named 'NVIDIA App' (because every brand needs a healthy dose of capitalization for no reason). But with it came a complete rework and the removal of perhaps some of the most obtuse design decisions ever made.

Long gone were the wonky 'click every traffic light in these many, many pictures' Captchas and mandatory logins. In its place was a super-slick and elegant program that finally just worked. GeForce Experience was so bad that many in the media industry actively avoided using it, and recommended others do the same (including ourselves); simply download the drivers from Nvidia's website when they update, and you'd be golden. It seems like Nvidia cottoned on to that at last, and the email address scrubbing lost its appeal.

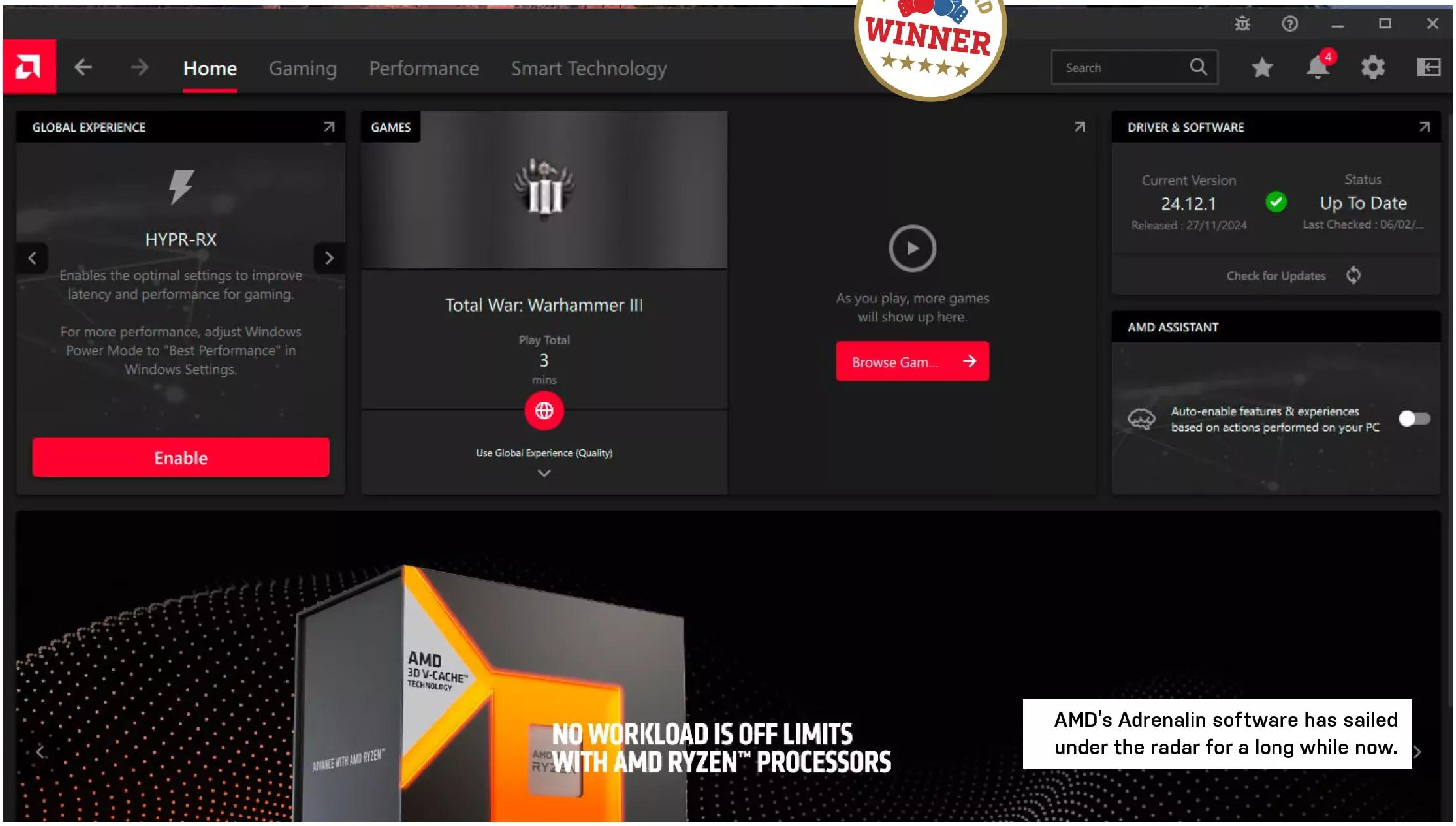
The new Nvidia app is radically cleaner than it was before; no awkward Captcha logins—or logins required at all, in fact. Get the driver installed, and you're all set. You can log in if you'd like, but it's mostly there for GeForce NOW and other services. Plus, you verify your account by, get this, an email sign-in. Genius!

On first load, the home page is fairly bare. There's little on display, but it does show certain elements that you might need, such as Nvidia Broadcast, Frameview for benchmarking, and GeForce Now. But most are web links leading to other programs to download, rather than being directly integrated into the program.

The driver segment has also had a revamp, with a handy list of bug fixes and features added with each update, including what games are supported and any new updates to them (DLSS 4 for example). You can also directly calibrate individual game titles and change settings, altering the config/ini files, and the system segment allows you to edit display settings quickly and easily without going into Windows settings.

The performance segments give you some rudimentary GPU stats, power draw, etc, but there's no logging feature or custom edits to what stats you want to see. Auto-overclocking is also included, but it's a one-click button. Nvidia's overclocking options are remarkably restricted in comparison to AMD's. It's

HEAD TO HEAD WINNER ★★★★★



Enables the optimal settings to improve latency and performance for gaming.

For more performance, adjust Windows Power Mode to "Best Performance" in Windows Settings.

As you play, more games will show up here.

Auto-enable features & experiences based on actions performed on your PC

AMD's Adrenalin software has sailed under the radar for a long while now.

almost as if you're expected to use MSI Afterburner, EVGA Precision or any of the other myriad AIB partner overclocking utilities instead. So for the folks not interested in tinkering and adjusting voltages, there's simply a 1-click solution.

There are deeper settings buried in control panel for the monitor and programs directly, but that's sadly still the archaic Windows XP-looking thing that freezes on load that it's always been. Still, it's a much improved revamp of GeForce Experience, and one we're glad to see land.

AMD ENTERS THE CHAT

It might struggle to compete at the high end and on the AI battlefield, but Team Red isn't pulling its punches on the software side of things. AMD Software: Adrenalin Edition is absolutely stacked with features. The home page is a little bit more useful than Nvidia's, with driver information directly on the page, plus a log of your most recent games.

The gaming tab breaks down into individual programs and games it detects, allowing you to control specific AMD settings for those titles. You can change color profiles, enable anti-lag, radeon chill, and so on. You can even tweak FreeSync profiles per title. Alternatively, the graphics tab lets you just pick a profile from a total of four and blanket apply the settings across everything.

The Performance tab is better, too. Not only do you get logging, but there's a ton of customization. AMD allows you to choose what info you wish to monitor, and integrates that into an overlay.

In the tuning segment, you can directly overclock the GPU either manually or with an automated profile. That auto-tuning in particular comes with four separate profiles: default, overclock GPU, overclock VRAM, and undervolt GPU. The latter of which is wildly unique, and the first we've seen (ideal for tuning down temps, power draw, and clock speeds slightly). It's seriously detailed, effectively eliminating the need for a third-party program like MSI Afterburner or EVGA Precision.

Go into the settings segment, and you'll find everything from system details to display configuration. There's even support to factory reset everything, which is a nice touch. There's a display section too, similar to Nvidia's, but again baked directly into the app, although you can't adjust display layout, like you can with Nvidia. You can tweak color profiles though, enable Adaptive Sync or VSR, or set up Privacy View, and there are links to other settings in Windows.

Unsurprisingly, given how far behind AMD is on marketshare, its software is wildly underused compared to Nvidia's. But the thing is, it's had far more time in its current form to develop. Not only that, but AMD needs to impress on every facet. It's fighting an uphill battle against an opponent that dominates in raw performance. For too long, Nvidia has rested on its laurels; it's had no need to tweak or re-release GeForce Experience. Still, out of the two, AMD's Adrenalin Edition has the edge, as long, of course, as you're using one of its cards. **–ZAK STOREY**

VERDICT 7

Nvidia App

➕ **LEVELLING UP** Clean new design; Vital tools where you need them; No login required; Ability to adjust monitor settings in the app.

➖ **UNNECESSARY CAPITALIZATION** Still not quite as advanced as AMD; Lacks logging; Overclocking features are very basic; Nvidia control panel is still a thing.

Free, www.nvidia.com

VERDICT 9

AMD Software: Adrenalin Edition

➕ **EPENIPHRINE VERSION** Outstanding feature set; Multiple tuning options; Undervolting; Per-program settings and options; Logging features built in; Most features built in directly.

➖ **MUCOSAL CONGESTION** Only available with Radeon; Lacks display control in app; Occasionally difficult to install.

Free, www.amd.com

© AMD

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Rig reminiscing
> Media management
> No SFF Ryzen love

One man's PC gaming history (and some of ours, too)

Reading your superb article delving into the early 3D market (January, page 37) brought back some incredible memories for me from the mid '90s. I started with the S3 Virge card, which was an amazing card for gaming; nearly bought a DX486, but it was over £2,000 at PCWorld at the time, so I decided to get my first gaming PC built and understand it better. I skipped the first Pentium 75 and 90, and got the P100, 32MB EDO RAM, and a 140MB Quantum Fireball HDD. Then I had the Diamond Monster 3D, which pretty much defined me as a PC gamer, and truly got me into 3D gaming.

When I got a Matrox Mystique (2MB, if I remember), it came bundled with *MechWarrior 2*, *Scorched Planet*, and *Destruction Derby 2* 'Mystique Editions'. To say I was in heaven was an understatement. I still have the games, but not the card. This was going to be my hobby for life, I said.

I then saw the Matrox Millenium card demoing *Nexus: The Jupiter Incident* at my local PC builder shop. I found out it was made for the Matrox Parhelia card. I can't remember how the demo got out, but I played it to death, and it stands out as some of the best audio and effects I've seen.

One reader's walk down memory lane unearthed *Tomb Raider*.

I've had the Voodoo 2/3 3000 3dfx (remember the SLI connector?) and cards right up to the Nvidia GeForce Ti 4600, which came bundled with *Morrowind* and the infamous DirectX 8.1 rain effects. How easily pleased I was, watching raindrops plop on the water at Balmoral. I played on an iiyama 17-inch Diamond Trinitron (degaussing!).

I remember getting the 3dfx patches for the likes of *Tomb Raider*, *EF2000: TACTCOM*,*MechWarrior*, *Quake*, *Duke Nukem 3D*. So, here I am, aged 61, many thousands of PC games behind me, and 34 years a PC gamer and scratch PC builder. I truly will die as a PC gamer, if licenses are not revoked on Steam. The saddest part of digital gaming: not owning anything anymore. No wonder the industry is in a mess. By the way, some of the above may be incorrect—I'm doing it off the top of my head.

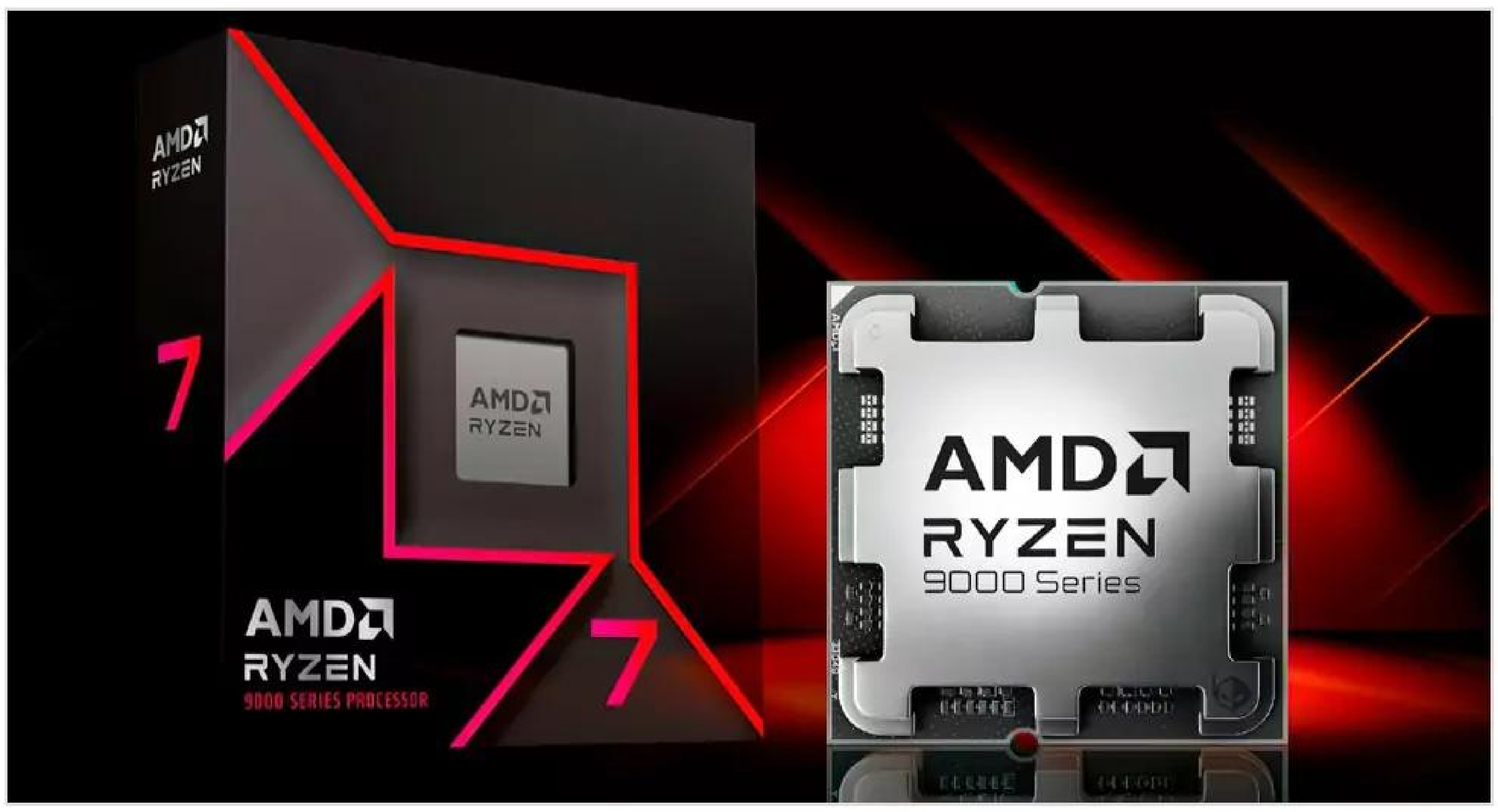
Cheers, and thanks for the memories – **Glen Eadie**

AUTHOR, JOHN KNIGHT, RESPONDS: Ah, lovely! My first 3D accelerator was a Voodoo 2, which we put inside a Pentium 133 we found in a skip. We pimped that out by overclocking it, adding more RAM, and giving it a Sound Blaster Live! The first game we ran was *Quake 2*, and we had our first 'whoah' moment when we saw proper 3D acceleration for the first time. We repeated the experience by taking it to our friends' houses and running *Quake 2* again!

All I can say for anyone wanting to experience one of those rare quantum leap moments is to try a SteamOS clone like Bazzite on a spare machine. The hybridization of PC and console is bizarre, but eye-opening: getting rid of that awful barrier Windows presents, and going straight into your PC games with a console interface, is a game changer. Plus, you can switch to desktop mode. It's inspired.

CONTRIBUTOR, JEREMY LAIRD, RESPONDS: I've got to have my say in this one, too. That's a great glimpse into one person's PC gaming history, Glen. On the off-chance you care, for me it all started with the Nvidia Riva TNT2. I can't remember what CPU I had, but it was outputting

↘ submit your questions to: editor@maximumpc.com


Where's all the Ryzen, we hear you ask?

to a 15-inch CRT and the impact of hardware T&L, which was the big innovation back then, was hard to overstate.

After that, there was an upgrade that was most notable for its 21-inch flat-screen Mitsubishi CRT using Trinitron technology. It's incredible to remember how huge that felt. Personally, I moved to laptops for a while after that. My first was a Dell Inspiron 4000 with a PIII CPU and an ATI Rage 128 graphics chip. That could play *Counter-Strike* pretty well at the laptop's 1,024 by 768 native res. Impressive, as you might say in a *Quake III*-style voice.

Then followed an Inspiron 5000 with a 15-inch 1,600 by 1,200 screen. I actually upgraded from Nvidia GeForce 2 Go to ATI Radeon 7000 Mobility. Imagine that—upgradeable laptop graphics. My next laptop was another Dell, an Inspiron 5000 with a 1,920 by 1,200 widescreen LCD that seemed incredibly high resolution at the time. Oh, and it had Nvidia GeForce 4 Go 4200 graphics. It really flew.

If I'm honest, nothing since has seemed quite so exciting as those early rigs and laptops. Maybe that's just the passage of time, but part of me believes that the generational upgrades back then were bigger than today. New hardware felt revolutionary in the way it rarely does now.

Serving up media

I've been a long-time subscriber since Brad Doslund was the editor (Boot). My first PC was a Tandy 1000EX. I am old, by the way. *Maximum PC* has given me the confidence to build a couple of machines myself. I'm now contemplating a media server. I have a large library of movies, music, and vacation pics. I would like to see a story or series of stories on NAS boxes (reviews), software, and setup tutorials. For me, value and simplicity are key. I don't need a MaximumNAS. I find it all a bit confusing between hardware brands and software (PLEX, Jellyfin, KODI, et al). I'm leaning toward PLEX, but I would prefer software without a subscription fee.

– Bob Edwards

CONTRIBUTOR, JEREMY LAIRD, RESPONDS: Hi Bob. We've had zillions of guides and tutorials over the years covering media servers from a practical perspective, along with various hardware reviews. One of the more recent was a how-to explaining how to organize your media server back in December 2022. In November last year, we had a guide on how to rip and convert all kinds of media, while June 2024 delved into converting media files specifically with VLC.

There are countless others. If you've been a subscriber since the good old days, I'd suggest we keep the reminiscing riff from Glen Eadie's letter on the previous page going as you leaf through various copies and digital issues of *Maximum PC* from yesteryear. Media servers and NAS technology haven't changed that much over the years, so much of it will still be relevant, even if specific hardware reviews may no longer be available.

Where's the Ryzen love?

I've just looked through your back issue catalog, and I'm wondering why there are no Ryzen processors in SFF builds in the past three years. Thanks.

– Angus Sutton

CONTRIBUTOR, ZAK STOREY, RESPONDS: Yeah, it's a tricky one, the ol' Ryzen ITX issue. I love ITX builds, and I'm a big fan of what AMD is doing with its processor line these days. However, the biggest issue we have currently is that there's just not enough interest in AMD SFF builds. Not from a publication perspective, but from an industry perspective.

Take AM5, for instance. If you're looking for ITX boards that are compatible with the socket right now, there's a grand total of 14. Two are discontinued, two are on the A620 chipset (generally unavailable to media), and three are on the latest B850 chipset that's just launched. That leaves seven boards across B650, 650E, X670E, and X870/E. With that, they're either ridiculously expensive (Asus's ROG Strix X870-I comes in at a staggering $586), or notoriously difficult to get out of manufacturers as samples, as they don't see them as volume drivers.

Compare that with ATX and E-ATX, and there are 144 boards to choose from for AM5. If you pick Intel's LGA 1700 socket (12th, 13th, and 14th gen), there are 45 ITX options. Even the LGA1851 socket has seven ITX options, and that's been out for just a few months now.

I'd love to chuck a Ryzen 9 9800X into an ITX rig (I'm hoping to do something similar to that soon with an RTX 50 series card), but if you're an ITX fanboy like I am and want to go the AMD route, 90 percent of the time, you're going to be held back by the boards more than anything else.

Copying our copy

At one time, I was able to copy and paste your articles into Microsoft Word so that I could use them for reference. I tried to do the same thing today with a great Windows article, and was not able to. Have you changed this on purpose, or am I doing something wrong?

I still think you have one of the best magazines on the planet. However, if I could copy/paste, it would be even better.

– Alexander J. Heim

CONTRIBUTOR, JEREMY LAIRD, RESPONDS: Alexander, this isn't the easiest query to answer. It's certainly the case that you can't copy and paste text from the Readly viewer. I'm not clear, but I suspect that has always been the case. Your mileage may vary using other magazine reading platforms. One option you have, should none of the readers allow copy-pasting—which is a little labour intensive, but should work—would be to take a screengrab and use an image-to-text OCR (optical character recognition) tool to extract the text. There are numerous ones available, but there should be one that plays nicely with *Maximum PC*'s page formatting.

© EIDOS INTERACTIVE, AMD

THE BUILDS

THIS MONTH'S STREET PRICES...

IT'S OUR FAVORITE TIME OF THE YEAR: when Nvidia launches a new series of graphics cards that immediately go out of stock due to low supply, and then every scalper and their mom buys up every possible graphics card available, reselling them at ridiculous prices. They're the worst kind of people. Sorry, they're not enthusiasts. Not even slightly. Trying to profit off people's desperation and misfortune is just grim, particularly when all they want to do is enjoy a hobby; an escape from the woes of the 21st century in whatever form that takes.

Anyway, with that ethical and moral rant out of the way, let's talk budget builds. Changes across both remain relatively stable; we've had a few changes here and there on pricing, but nothing major. Hilariously, our primary SSD, the P3 Plus, fell by $1, and our secondary SSD increased by $1. We also saw a slight price drop on the 9600X, along with a fairly chunky $10 increase for last issue's motherboard on the AMD system. We've ditched the Eagle WiFi6E in favor of the stock standard Gaming WiFi6, which is just as potent, with plenty of connectivity, but it brings the price back down to that $170 mark.

Similarly for our Intel setup, the RX 7600 shot up by over $40. Fortunately, XFX saved the day with its Speedster SWFT 210 edition, which although cheaper than pretty much every RX 7600 card out there right now, bumped the prices up by $10 as a result.

Fortunately, the damage hasn't been too harsh. AMD's system cost has decreased by a smooth $5, and our Intel rig is up by $16. That leaves us with two comfortable sub-1K entry-level builds—perfect for 1080p gaming and most other things a PC can do.

Speaking of things we're keen to change, that Intel Core i5-14400F is starting to drag on us a little. However, the Ultra 5 245KF is still stuck at about $100 more, and there's no Ultra 3 or availability on the 225 either yet.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks XT View	$90
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$60
Mobo	Gigabyte B850 Gaming WiFi6 ATX **NEW**	$170
CPU	AMD Ryzen 5 9600X	$240
Cooler	be quiet! Pure Rock Slim 2	$25
GPU	Sparkle ORC OC A750 8GB	$200
RAM	32GB (2x 16GB) Silicon Power XPOWER Pulse Gaming @ 6,400 C32	$88
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2	$40
SSD 2	1TB Klevv CRAS C910 PCIe 4.0 M.2	$51
OS	Windows 11 Home 64-bit OEM	$22

Approximate Price: $986

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks XT View	$90
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$60
Mobo	MSI Pro Z790-S WiFi ATX	$140
CPU	Intel Core i5-14400F	$165
Cooler	be quiet! Pure Rock Slim 2	$25
GPU	XFX Speedster SWFT 210 Core RX 7600 8GB **NEW**	$260
RAM	32GB (2x 16GB) Silicon Power Value Gaming @ 6,000 C30	$88
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2	$40
SSD 2	1TB Klevv CRAS C910 PCIe 4.0 M.2	$51
OS	Windows 11 Home 64-bit OEM	$22

Approximate Price: $941

MID-RANGE

ON TO THE MID-RANGE NOW, and this is where things are starting to get a little ropey. Price changes are afoot one and all, and it ain't looking pretty. Our Hyte Y40 has increased back up to $120. Although not terrible, it is challenging, given the H5 Flow is now sub-$90 in some formats, and boy is that a good case.

Similarly, for our AMD build, we've had to change out our motherboard for the X870 ASRock Pro RS. Last month's pick shot up by $20—we managed to eliminate that price bump by opting for the slightly lower-specced Pro RS. That's not great, but it'll keep us under $1,500. Similarly, the RX 7700 XT got sniped a touch, with the price shooting up by $30. We've gone with another ASRock pick: the Challenger OC, dropping the price by $51, which is actually cheaper than last month. Nice.

Annoyingly, on the storage front, the Lexar NM790 had its price increased by $15. We're a little curious if this might be in response to the trade tariffs building up, and Lexar not quite being on the ball with its Chinese-manufactured NAND. Either way, we've gone for Corsair's much better-performing MP600 Elite, dropping the price to a smooth $75 across both systems.

As for our Intel build, what a sorry state of affairs this was. Good news: the 14700F fell by another $44, bringing it down to $273. Bad news: the motherboard shot up by $20, so we've swapped it out for... well, there's no easy way of putting this: an ASRock Z790 PG Sonic. It's well equipped, but plastered with Sonic the Hedgehog artwork. Why? Good question.

Then there's the GPU, the first hint that things are going wrong; all of the RTX 4070s are now $250 more expensive than they were last month. Yep, this is definitely a stock thing, as the 4070 Supers are only $50 more. But still, that was a painful pill to swallow, and it pushes our Intel rig up by $21 on last month (our AMD rig fell by $8).

AMD INGREDIENTS

PART			PRICE
Case	Hyte Y40 ATX Mid Tower		$119
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold		$91
Mobo	ASRock X870 Pro RS	NEW	$200
CPU	AMD Ryzen 7 9700X		$314
Cooler	Noctua U12S chromax.black		$90
GPU	SRock Challenger OC RX 7700 XT 12GB	NEW	$389
RAM	32GB (2x 16GB) TeamGroup T-Create Expert @ 6,400 C32		$88
SSD 1	1TB Corsair MP600 Elite M.2 PCIe 4.0 SSD	NEW	$75
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD		$91
OS	Windows 11 Home 64-bit OEM		$22
Approximate Price:			**$1,479**

INTEL INGREDIENTS

PART			PRICE
Case	Hyte Y40 ATX Mid Tower		$119
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold		$91
Mobo	ASRock Z790 PG Sonic ATX	NEW	$160
CPU	Intel Core i7-14700F		$273
Cooler	Razer Hanbo Chroma - 360mm AIO		$80
GPU	MSI Ventus 2X OC RTX 4070 Super 12GB	NEW	$600
RAM	32GB (2x 16GB) Silicon Power Xpower Zenith Gaming @ 6,000 C30		$80
SSD 1	1TB Corsair MP600 Elite M.2 PCIe 4.0 SSD	NEW	$75
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD		$91
OS	Windows 11 Home 64-bit OEM		$22
Approximate Price:			**$1,591**

TURBO

GEOMETRIC FUTURE
MODEL
05
GEOMETRIC FUTURE

OH BOY, OH BOY, oh boy. Dread; pure dread, writing this section. Let's take it slow, nice and steady, and talk about the wins, yeah? So, er, the good news: Geometric Future's Model 5 only increased in price by $1. Phew. Most of the memory kits stayed stable, with the Patriot Viper only increasing by $5, and both the coolers only increased in cost by $10.

Kind of expected, these prices shift upward with the launch of new top-tier graphics cards. Manufacturers assume, of course, that folk are going to be looking to build new systems around the RTX 50 series and so forth.

We did have quite the large blip with our PSU of choice, however; across both systems, EVGA's SuperNova bounced up by an incredible $140. That's wild for an ATX 3.1 PSU power jump, and one we could absolutely not stomach. Sorry, EVGA, your warranty might be good, but it isn't that good. Instead, we've dropped back to an old trusty faithful in the form of Super Flower's LEADEX VII Platinum Pro. Still 1000W, still 80+ platinum, still ATX 3.1 compliant, but for just $198. $5 less than last month. Huzzah!

We've also decided that it was time to chuck out the old Core 9 series, and moved the entire Intel system over to the Core Ultra 9 285K. With enough Windows and BIOS updates, we're finally convinced that the performance is worth it. That does bring in some cost, with a not so stealthy $166 price increase on the CPU, but yeah, it's worth it in the long term.

Then there are the GPUs. All of AMD's RX 7900 XTX line are either out of stock or available for a month-on-month price increase of $276. Great. Because of that, we've had to massively downgrade and grab the standard 7900 XT instead, losing out on that extra performance. Thankfully, it gives us a saving of $516 compared to if we'd stayed with the XTX.

For our Intel build, all of the 4080s have gone, and the 4080 Supers are now up by a minimum of $142. The cheapest Super is on pre-order at $1,100. Yay. A year-old card, retailing 10 percent higher than its meant to. On pre-order.

AMD INGREDIENTS

PART		PRICE
Case	Geometric Future Model 5	$140
PSU	Super Flower LEADEX VII Platinum Pro 1000W - 80+ Platinum **NEW**	$198
Mobo	Gigabyte X870E Aorus Elite WiFi7 ATX	$320
CPU	AMD Ryzen 9 9950X	$576
Cooler	NZXT Kraken 360 360mm AIO	$180
GPU	ASRock Phantom Gaming OC Radeon RX 7900 XT 20GB **NEW**	$690
RAM	64GB (2x 32GB) Patriot Viper Venom @ 6,400 C32	$140
SSD 1	2TB Crucial T700 PCIe 5.0 M.2	$270
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2	$157
OS	Windows 11 Home 64-bit OEM	$22

Approximate Price: **$2,693**

INTEL INGREDIENTS

PART		PRICE
Case	Geometric Future Model 5	$140
PSU	Super Flower LEADEX VII Platinum Pro 1000W - 80+ Platinum **NEW**	$198
Mobo	Gigabyte Z890 Aorus Elite WiFi7 **NEW**	$260
CPU	Intel Core Ultra 9 285K **NEW**	$600
Cooler	Asus ROG Strix LC II ARGB 360mm AIO	$155
GPU	Asus TUF Gaming OC RTX 4080 Super 16GB **NEW**	$1,100
RAM	64GB (2x32GB) TeamGroup T-Create Expert @ 6,000 C34	$166
SSD 1	2TB Crucial T700 PCIe 5.0 M.2	$270
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2	$157
OS	Windows 11 Home 64-bit OEM	$22

Approximate Price: **$3,068**

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